UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In response refer to:
2009/00833

JUL 21 2009

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Office of Energy Projects
888 First Street, N.E.
Washington, D.C. 20426

Dear Secretary Bose:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (BO) (Enclosure 1) based on our review of the proposed Federal Energy Regulatory Commission (FERC) license amendment for the Battle Creek Hydroelectric Project (P-1121), on Battle Creek in Shasta and Tehama Counties, California, and its effects on Federally-listed endangered Southern Resident killer whale (*Orcinus orca*), endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), and their designated critical habitat, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your request for formal consultation was received on March 3, 2009. Formal consultation was initiated by NMFS' Sacramento Area Office.

This BO is based on information provided in the Biological and Essential Fish Habitat Assessment (provided on March 3, 2009), the FERC license amendment application, supporting material for the Battle Creek Salmon and Steelhead Restoration Project, several meetings with Pacific Gas and Electric Company and their consultants, field investigations, and other sources of information. A complete administrative record of this consultation is on file at the NMFS' Sacramento Area Office.

Based on the best available scientific and commercial information, the BO concludes that this project is not likely to jeopardize the continued existence of the above listed species, or adversely modify critical habitat. NMFS has also included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to minimize incidental take associated with the Battle Creek Hydroelectric project.

Also enclosed are EFH conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act as amended (16 U.S.C. 1801 *et seq.*; Enclosure 2). This document concludes that continued operations of the Battle Creek Hydroelectric project after Phase 1A of the Restoration Project is complete will adversely affect the EFH of Pacific salmon in the action area and adopts the ESA conservation recommendations of the BO as the EFH conservation recommendation.

Please contact Ms. Naseem Alston at (916)930-3655, or via e-mail at Naseem.Alston@noaa.gov if you have any questions concerning this matter, or require additional information.

Sincerely,

Anthony G Martin

for Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Copy to file – ARN # 151422SWR1999SA1277
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Enclosure 1

BIOLOGICAL OPINION

Agency: Federal Energy Regulatory Commission
Washington, D.C.

Activity: Battle Creek Hydroelectric Project (1121-087-California)

Consultation Conducted By: Southwest Region, National Marine Fisheries Service

File Number: 151422SWR1999SA1277

Date Issued: JUL 21 2009

I. CONSULTATION HISTORY

On June 22, 2005, NMFS completed the Biological Opinion (BO) for construction of the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project). Development of the Restoration Project was initiated in 1999 through the formation of partnerships supportive of restoration activities throughout the Battle Creek watershed. These partners included: the U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (FWS), NOAA's National Marine Fisheries Service (NMFS), California Department of Fish and Game (CDFG), and Pacific Gas and Electric Company (PG&E) and through the contributions and efforts of the public, interested parties, the Greater Battle Creek Working Group (GBCWG), the Battle Creek Watershed Conservancy, the California Bay Delta Authority (CALFED), the California State Water Resources Control Board (SWRCB), and the Federal Energy Regulatory Commission (FERC).

On July 18, 2008, PG&E submitted a License Amendment Application for the Battle Creek Hydroelectric Project 1121 (Hydroelectric Project), in support of Phase 1A of the Restoration Project. On September 19, 2008, FERC designated PG&E as the non-federal representative for consultation for the purpose of informally consulting with NMFS. On February 26, 2009, PG&E provided a Biological Assessment (BA) to FERC. FERC requested initiation of formal consultation with NMFS on March 3, 2009.

II. DESCRIPTION OF THE PROPOSED ACTION

A. Project Activities

1. Project Background

The Hydroelectric Project operation information that follows is based on historical operation and anticipated characteristics following implementation of the modifications associated with the Restoration Project. The complete Restoration Project includes three phases (Phases 1A, 1B, and 2). This consultation will analyze the effects of Phase 1A of the project only, as this is the only action proposed in PG&E's application to the Federal Energy Regulatory Commission (FERC) for amendment of license for the Hydroelectric Project. Each separate phase has independent value for fisheries restoration on Battle Creek, and neither is dependent on the others to provide those benefits.

The Restoration Project presents an opportunity to reestablish approximately 42 miles of prime salmon and steelhead habitat on Battle Creek, plus an additional 6 miles of habitat on its tributaries. Restoration would be accomplished primarily through the modification of the Hydroelectric Project facilities and operations, including instream flow releases.

The recognition of the decline in salmon and steelhead populations in the Sacramento Valley and its tributaries has led to several legislative mandates to restore the fishery. The most relevant state planning process that initiated restoration on Battle Creek was the California Resources Agency's Upper Sacramento River Fisheries and Riparian Management Plan (Upper Sacramento River Fisheries and Riparian Habitat Advisory Council 1989), which involved public agencies, local government/communities, and stakeholders. Much of this state plan later was embodied in the Central Valley Project Improvement Act (CVPIA), which also includes the Anadromous Fish Restoration Program (AFRP). The Restoration Project is part of a larger basin-wide effort described in the California Bay Delta Program (CALFED) Ecosystem Restoration Program Plan (ERPP) (CALFED Bay-Delta Program 2000). A focus of the ERPP is salmon and steelhead populations, the primary focus for the habitat improvements proposed for the Restoration Project (Jones & Stokes 2005).

The Restoration Project involves modifications to facilities at nine dam sites located on North Fork Battle Creek, South Fork Battle Creek, Baldwin Creek, Lower Ripley Creek and Soap Creek (Figure 1). The MOU signatories have decided to implement these modifications in phases, each of which has independent ecological and environmental benefits.

The Restoration Project proposes to re-operate and modify the hydropower facilities on North Fork and South Fork Battle Creek and three of its minor tributaries: Soap, Ripley, and Baldwin Creeks. Reoperation would increase and stabilize streamflow for the purpose of significantly increasing cold water and stream area and providing a reliable migratory pathway over obstacles in the project area. The proposed action also would modify the facilities at remaining diversion dams to substantially improve the reliability and effectiveness of upstream and downstream fish passage (Table 1). New fish screens and fish ladders that meet NMFS and CDFG criteria would be constructed at three diversion dams (North Battle Creek Feeder, Eagle Canyon, and Inskip Diversion Dams). Five diversion dams would be removed (Wildcat, South, Coleman, Soap

Creek Feeder, and Lower Ripley Creek Feeder Diversion Dams). In areas where North Fork and South Fork waters have been mixed together in the power canals, facilities to connect the tailrace of one powerhouse to the canal headworks of the next are proposed to prevent the discharge of mixed water back into the natural stream channels. Higher minimum flow requirements (i.e., MOU minimum flow requirements) would increase instream flows, subsequently cooling water temperature, increasing stream area, and providing reliable passage conditions for adult salmonids in downstream reaches. In addition, the MOU minimum flow requirements support future adaptive management that may incorporate new information related to flows needed to facilitate passage, increase habitat area, and improve water temperature conditions (Jones & Stokes 2005).

Phase 1A includes facility modifications on North Fork Battle Creek, Eagle Canyon Canal, and Asbury Dam. For Phase 1A, fish passage improvements on North Fork Battle Creek will be achieved by installing fish screens and ladders at the North Battle Creek Feeder and Eagle Canyon Diversion Dams; installing the Eagle Canyon Canal pipeline; removing the Wildcat Diversion Dam and appurtenant conveyance systems; and modifying the Asbury Dam.

Phase 1B and Phase 2 are not part of this consultation, but are briefly described below.

Phase 1B improvements on the lower South Fork Battle Creek include installing a tailrace connector from Inskip Powerhouse to Coleman Canal and a new Inskip Powerhouse bypass.

For Phase 2, additional fish passage improvements on the South Fork Battle Creek are proposed by removing the South, Soap Creek Feeder, Lower Ripley Creek Feeder, and Coleman Diversion Dams; installing a fish screen and ladder on the Inskip Diversion Dam; installing a tailrace connector from South Powerhouse to Inskip Canal; and decommissioning the South Canal. Figure 2 shows the post-restoration configuration.

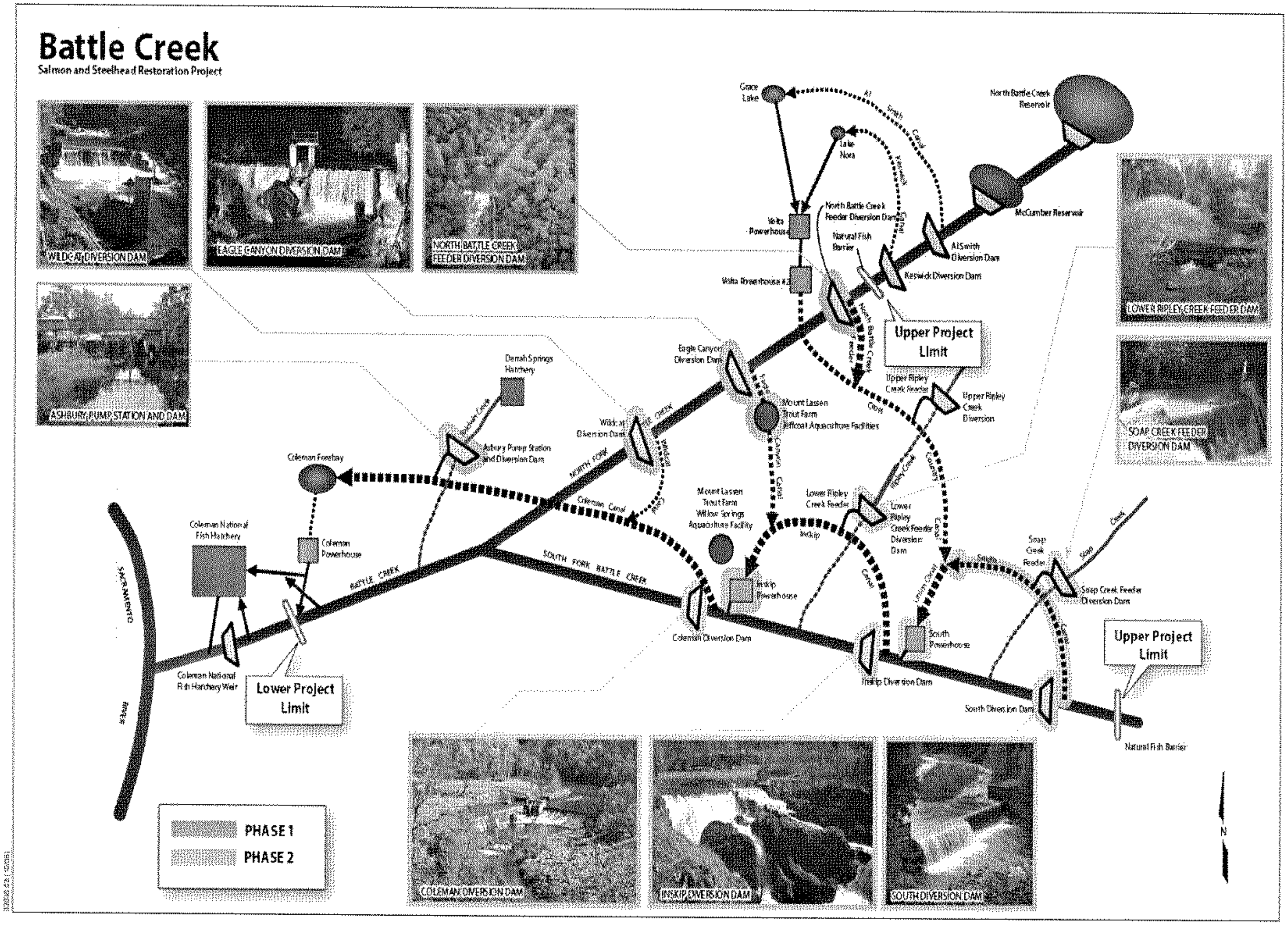


Figure 1
Restoration Project Facilities and Project Phases

Table 1. Summary of individual components of each phase of the Restoration Project.

Site Name Component	Phase 1A	Phase 1B	Phase 2
North Battle Creek Feeder Diversion Dam	Install fish screen and ladder Set new minimum instream flow for N. Battle Creek Feeder reach ranging from 47 to 88 cfs Improve access road		
Eagle Canyon Diversion Dam and Canal	Install fish screen and ladder Remove segment of the Eagle Canyon spring collection facility Set new minimum instream flow for Eagle Canyon reach 35 to 46 cfs Improve access trail Replace section of Eagle Canyon Canal with buried pipeline		
Wildcat Diversion Dam, Pipeline, and Canal	Remove dam, pipeline and canal Improve access roads and trail		
South Diversion Dam			Remove dam
Soap Creek Feeder Diversion Dam			Remove dam
Inskip Diversion Dam and South Powerhouse			Install fish screen and ladder Construct South Powerhouse and Inskip Canal connector (tunnel) Set minimum instream flow for Inskip reach ranging from 40 to 86 cfs
Lower Ripley Creek Feeder Diversion Dam			Remove dam
Coleman Diversion Dam and Inskip Powerhouse		Construct Inskip Powerhouse and Coleman Canal connector Replace Inskip Powerhouse bypass Improve access road	Remove dam
Asbury Diversion Dam	Install instream flow release monitoring and recording equipment Set minimum instream flow for Baldwin Creek at 5 cfs Modify dam to provide fish barrier		
cfs= cubic feet per second			

a. Interim Flow Agreement between PG&E and Reclamation

Since 1996, as part of the planning phase of the Restoration Project, Reclamation has entered into interim flow agreements with PG&E to maintain higher minimum instream flows below the Eagle Canyon and Coleman Diversion Dams until the long-term Restoration Project could be implemented on Battle Creek. A second element of these agreements includes the closing of the fish ladders on Eagle Canyon and Coleman Diversion Dams to keep fish in the areas where the agreement's increased flows could maintain suitable habitat, and to prevent juvenile fish from becoming entrained into the hydro-diversions above these dams. The interim flow agreements represent a short-term set of resource conditions that are directly related to the Restoration Project. These interim flow agreements are not guaranteed to continue and are not considered to be baseline conditions on Battle Creek.

The history of the interim flow agreements since 1996 includes:

- Contract No. 6-07-20-W1379 from October 1996 to February 1998;
- Agreement No. 8-07-W1528 from November 1998 to February 2001;
- Agreement No. 03-WC-20-2554 from September 2003 to December 2005; And
- Agreement No. 06-WC-20-3522 from August 2006 to present.

An Interim Flow Science Team was established that consists of representatives from PG&E, Reclamation, NMFS, USFWS, and CDFG and a stakeholder representative from the Battle Creek Working Group, or any successor stakeholder group. The Interim Flow Science Team provides scientific information to Reclamation and PG&E related to changes in hydrologic and climatic conditions, instream habitat conditions, and fishery data and may temporarily modify the flow objectives set in the Interim Flow Agreement.

2. Current Hydroelectric Project

The Hydroelectric Project was developed in the early 1900s. The Hydroelectric Project consists of five powerhouses (Volta, Volta 2, South, Inskip, and Coleman), two small upstream storage reservoirs (North Battle Creek and Macumber), three forebays (Grace, Nora, and Coleman), five diversions on North Fork Battle Creek (Keswick, Al Smith, North Battle Creek Feeder, Eagle Canyon, and Wildcat), three diversions on South Fork Battle Creek (South, Inskip, and Coleman), numerous tributary and spring diversions, and a network of some 16 canals, ditches, flumes, tunnels, and pipelines (Figure 1). The Hydroelectric Project was acquired by PG&E in 1919. It was licensed initially by the Federal Power Commission in 1932 and was relicensed by FERC in 1976 for a period of 50 years. The current FERC License sets the minimum instream flow requirements at 5 cubic feet per second (cfs) in South Fork Battle Creek and 3 cfs in North Fork Battle Creek. Several of the tributaries (Soap, Ripley, and Baldwin Creeks) have no minimum instream flow requirements.

a. *Hydroelectric Project Water Routing*

The Hydroelectric Project currently diverts water from North Fork and South Fork Battle Creek and several tributaries. Diversions from North Fork Battle Creek are made at North Battle Creek

Feeder, Keswick, Al Smith, Eagle Canyon and Wildcat Diversion Dams; diversions from South Fork Battle Creek are made at South, Inskip, and Coleman Diversion Dams. Diversions from South Fork Battle Creek tributaries include Soap Creek Feeder, Upper Ripley Creek Feeder and Lower Ripley Creek Feeder. Diversions from Battle Creek mainstem tributaries include Asbury Diversion Dam on Baldwin Creek. All of these diversions are unscreened, allowing any fish in the vicinity of the diversions to be entrained into the hydropower system.

A portion of North Fork water is conveyed from its natural drainage across a plateau through a series of tunnels, flumes, and open channels to the South Fork. South Fork water is similarly conveyed, although it remains within its natural drainage. Water from the two forks is ultimately collected into penstocks and dropped down to the South, Inskip, and Coleman Powerhouses situated on the north banks of South Fork Battle Creek and mainstem Battle Creek.

Occasionally, the powerhouses are shut down because of maintenance or because of lightning strikes, transmission grid disruptions, or other emergencies. When this occurs on the South Fork, the South and Inskip Powerhouse penstock intakes are shut off. In emergency conditions, water in the canals feeding South Powerhouse is discharged via a bypass to South Fork Battle Creek until the diversions into the canals can be shut down. Water in the canals feeding Inskip Powerhouse is diverted via a bypass facility back into South Fork Battle Creek until the diversions into the canals can be shut down. Water in the canal feeding Coleman Powerhouse also can be discharged into South Fork Battle Creek and mainstem Battle Creek depending on the circumstances and discharge location along the canal. One of the objectives of the Restoration Project is to essentially eliminate the discharge of North Fork Battle Creek water to South Fork Battle Creek above the natural confluence.

b. *Fish Ladder Operations*

The North Battle Creek Feeder, Eagle Canyon, Wildcat, Coleman, Inskip, and South Diversion Dams potentially block approximately 48 miles of upstream habitat, including 42 miles of spawning and rearing habitat in Battle Creek and an additional 6 miles of spawning and rearing habitat in its tributaries. Soap Creek Feeder and Lower Ripley Creek Feeder also potentially block fish passage because they do not have fish ladders. The fish ladders at Eagle Canyon, Wildcat, and Coleman Diversion Dams are considered ineffective under most flow conditions (California Department of Water Resources 1997 and 1998). The fish ladder effective flow range for each diversion dam is between 2 and 7 cfs. The ladder at the South Diversion Dam has an effective flow range between 3 and 35 cfs. The ladders proved impossible to maintain during high flows. During average or wet water years, fish ladders at North Battle Creek Feeder, Eagle Canyon, Wildcat, Inskip, and Coleman Diversion Dams could be ineffective for 3 to 8 months because flow exceeds the maximum effective capacity of the ladders by a factor of 10 or more. Fish ladders at Eagle Canyon and Coleman Diversion Dams intentionally were closed to fish passage under the 1998 Interim Agreement to keep spawning fish in the areas below these dams where stream flows were maintained at suitable levels, and to prevent juvenile fish from being entrained into the hydropower system through the unscreened diversions above these dams (Jones & Stokes 2005).

3. Proposed Facility and Operational Modifications

Phase 1A will begin with the facility modifications on North Fork Battle Creek, Eagle Canyon Canal, and Asbury Dam. For Phase 1A, fish passage improvements on North Fork Battle Creek will be achieved by installing fish screens and ladders at the North Battle Creek Feeder and Eagle Canyon Diversion Dams; installing the Eagle Canyon Canal pipeline; removing the Wildcat Diversion Dam and appurtenant conveyance systems; and modifying the Asbury Dam to prevent fish passage.

Water in the North Fork will continue to flow to mainstem Battle Creek and also will be routed to the South Fork facilities through North Battle Creek Feeder and Eagle Canyon Diversion Dams to the Cross Country Canal and Eagle Canyon Canal, respectively. Wildcat Diversion Dam and appurtenant conveyance systems will be decommissioned and removed. Spring water diversion facilities at Eagle Canyon Diversion Dam will be removed, allowing the spring water to flow into North Fork Battle Creek, eliminating the possibility of diversion of these spring waters into South Fork Battle Creek.

South Powerhouse will continue to receive water from Union Canal, a combination of flows from the South and Cross Country Canals, and Soap Creek Feeder Diversion Dam. After passing through the South Powerhouse, the combined waters will continue to be discharged to South Fork Battle Creek. At this location, water from South Fork Battle Creek can be diverted at the Inskip Diversion Dam to the Inskip Canal and Powerhouse. The Inskip Canal also is fed by the Eagle Canyon Canal and Lower Ripley Creek Feeder Diversion Dam. The discharge from Inskip Powerhouse will continue to flow into South Fork Battle Creek where it can be diverted into Coleman Canal. Coleman Canal feeds Coleman Powerhouse, situated farther downstream on mainstem Battle Creek.

a. *Instream Flow Modifications*

Modifications to instream flows are a key component of the Restoration Project. The BCWG Biological Technical Team collaborated on the development of a detailed minimum flow release schedule for each dam. The team included biologists from the fishery agencies and PG&E, and participants from the BCWG. The proposed flow schedule addressed species habitat needs by stream reach and included the flows necessary to address passage and water temperature needs. The minimum instream flows that relate to baseline conditions, Phases 1A Restoration Project conditions, are set forth in Table 2.

Table 2. Phases 1A Restoration Project Monthly Minimum Instream Flow Requirements

	Monthly Minimum Flow Release (cfs)											
Dam	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North Fork Battle Creek												
North BC Feeder	88	88	88	67	47	47	47	47	47	47	47	88
Eagle Canyon	46	46	46	46	35	35	35	35	35	35	35	46
Wildcat	Facility removed; no instream flow requirement											
South Fork Battle Creek												
Coleman[1]	5(30)	5(30)	5(30)	5(30)	5(30)	5(30)	5(30)	5(30)	5(30)	5(30)	5(30)	5(30)
Baldwin Creek												
Asbury	5	5	5	5	5	5	5	5	5	5	5	5

1 For Phase 1, the FERC minimum instream flow requirement below Coleman Dam will remain at 5 cfs year round. The 30 cfs instream flow requirement below Coleman Dam is the result of an Interim Flow Agreement between Reclamation and the Licensee and is not contained in the MOU. After Coleman Dam is removed in Phase 2, there will be no instream flow requirement at that location.

b. *Ecological Process Changes*

The goal of the Restoration Project is to restore the ecological processes necessary for the recovery of steelhead and Chinook salmon populations in Battle Creek and to minimize the loss of clean and renewable electricity that may result from modifications to the Hydroelectric Project. The Restoration Project would modify Hydroelectric Project facilities and operations to provide water management in Battle Creek consistent with the life cycle needs of anadromous fish. Specifically, the Restoration Project contemplates that the following modifications to the Hydroelectric Project would result in the restoration of ecological processes that support anadromous fish:

- adjustments to Hydroelectric Project operations, including allowing cold spring water to reach natural stream channels, reducing the amount of water diverted from streams, and decreasing the rate and manner in which water is withdrawn from the stream and returned to the canals and powerhouses following outages;
- modification of facilities, such as fish ladders, fish screens and bypass facilities, diversion dams, and canals and powerhouse discharge facilities to improve passage and stabilize habitat conditions; and
- changes in the approach used to manage the Hydroelectric Project to better balance hydroelectric energy production with habitat needs, using ecosystem-based management that protects and enhances fish and wildlife resources and other environmental values using adaptive management, reliable facilities, and water rights transfers, among other strategies.

B. Proposed Conservation Measures

1. Proposed Conservation Measures

The conservation measures for the Restoration Project will be implementation of the Adaptive Management Plan (AMP) and the Facility Monitoring Plan. The AMP monitors salmonid populations and their use of habitat within the action area. The AMP will be implemented by U.S. Fish and Wildlife Service. The Facility Monitoring Plan monitors the operations and facilitates maintenance of the new fish ladders and fish screens. The Facility Monitoring Plan will be implemented by PG&E.

2. Adaptive Management Plan

The adaptive management objectives outlined in the AMP focus on management of hydroelectric operations within the Restoration Project to facilitate habitat changes beneficial to salmon and steelhead. A corresponding increase in salmon and steelhead populations is expected as a result of these management actions. Measuring such increases is practical for larger populations such as steelhead, but proving statistically significant responses to fish populations currently at extremely low levels, such as winter-run Chinook, may not be possible. Therefore, trigger events leading to adaptive management actions will not be based solely on population data but also will rely on measurements indicating habitat conditions. The AMP objectives do not include or exclude existing or potential future propagation or supplementation activities, nor do they include specific "active" experimentation of proposed instream flows or experimental changes to Hydroelectric Project facilities to elucidate relationships between management actions and ecological processes, nor do they address the possibility of future development within Battle Creek (Terraqua Inc. 2004).

The AMP objectives for the restoration of salmon and steelhead focus on improvements in population dynamics, improvements to the habitat, and improvements designed to ensure safe passage of adults and juveniles. The population objectives are (1) ensure successful salmon and steelhead spawning and juvenile production, (2) restore and recover the assemblage of anadromous salmonids (i.e., winter-run Chinook, spring-run Chinook, steelhead) that inhabit the stream's cooler reaches during the dry season, (3) restore and recover the assemblage of anadromous salmonids that enter the stream as adults in the wet season and spawn upon arrival, and (4) ensure salmon and steelhead fully use available habitat in a manner that benefits all life stages, thereby maximizing natural production and full utilization of the ecosystem carrying capacity. Objectives focusing on improving the habitat of salmon and steelhead are (1) maximize habitat quantity through changes in instream flow, (2) maximize habitat quantity by ensuring safe water temperatures, (3) minimize false attraction and harmful fluctuation in thermal and flow regimes resulting from planned outages or detectable leaks from the Hydroelectric Project, and (4) minimize the stranding and isolation of salmon and steelhead resulting from variations in flow regimes caused by Hydroelectric Project operations. Objectives for the safe and reliable passage of salmon and steelhead are (1) provide upstream passage of adults at dams, (2) provide downstream passage of juveniles at dams, and (3) provide upstream passage of adults to their appropriate habitat over natural obstacles while ensuring appropriate levels of spatial separation between runs (Terraqua, Inc. 2004).

To determine whether the population objectives of the AMP are being met, assessments of population size, trends in productivity, population substructure, and population diversity must be compared to corresponding guidelines set forth by NMFS. The AMP has adopted NMFS's definitions of *viable populations* as the intermediate population goal and identifies the maximization of salmon and steelhead production and full utilization of carrying capacity as the final goal. The fish passage objectives are intended to assist in restoring natural process of dispersal and the habitat objectives will work to restore natural ecological variation associated with the natural function of the ecosystem. Further threats to population diversity not covered by the AMP objectives will be addressed through the AMP "linkages" (Terraqua, Inc. 2004).

Meetings of the Adaptive Management Technical Team (AMTT) will be scheduled four times per year, including an annual meeting in March, when possible Adaptive Management actions will be considered. The Adaptive Management Policy Team (AMPT) will meet at least annually in late March. These March meetings of the AMTT and AMPT are scheduled to finalize annual reports in time for funding agency deadlines. Ad hoc meetings may be scheduled by the AMTT or AMPT to address emergencies without advance public notice, but such meetings will consider only the emergency at hand. All meetings will be open to the public, and all scheduled meetings will be announced to the public. Protocols also specify meeting announcement requirements, voting rules, report writing, adaptive management responses, proposal ranking, modification of adaptive management objectives, and dispute resolution (Terraqua, Inc. 2004).

3. Facility Monitoring Plan

A detailed facility monitoring plan has been prepared by PG&E in consultation with the other parties to the Restoration Project. The draft monitoring plan delineates a program related to the Restoration Project's components that expands on typical FERC license monitoring requirements. The focus of this plan is to monitor compliance with new instream flows and the performance of new fish ladders and fish screens, all of which are elements of the Restoration Project. PG&E will perform and assume the costs for the following facility monitoring:

- verifying operations at the various outlet and spillway works for North Battle Creek Feeder, Eagle Canyon, Inskip, and Asbury (Baldwin Creek) Diversion Dams by monitoring properly calibrated remote sensing devices that continuously measure and record total flow and the fluctuation of stage immediately below each dam during all operations;
- periodically measuring spring flow to determine its contribution to the instream flow requirement below Eagle Canyon Diversion Dam and provide confirmation that facilities have not been installed to capture this water for conveyance to Eagle Canyon Canal;
- monitoring stream stage for ramping purposes at an appropriate location at the facility;
- identifying debris problems at the fish ladders at North Battle Creek Feeder, Eagle Canyon, and Inskip Diversion Dams by operating properly calibrated remote sensing devices that continuously monitor water surface elevations at the tops and bottoms of the ladders;

- operating an underwater video camera to document ladder effectiveness and fish movement through the ladder during the initial 3-year period of operation (or potentially longer) as provided in the terms of the MOU;
- identifying instances of plugging at the fish screens at North Battle Creek Feeder, Eagle Canyon, and Inskip Diversion Dams by operating properly calibrated remote sensing devices that continuously monitor water surface elevation differences on the inlet and outlet sides of the screens (if the monitoring reports a critical malfunction of the screen, the failsafe feature would shut down the inlet to the canal until the situation has been remedied); and
- recording operation of waste gates, overpours, and spillways during dewatering of the conveyance for maintenance or to release excess water during emergencies.

PG&E will perform all necessary maintenance on and replacement of the fish screens, fish ladders, and stream gages as indicated by the monitoring plan, once PG&E has accepted these structures from Reclamation as being released for operation.

C. Description of Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action. The action area for this project includes that portion of Battle Creek and all of its tributaries between the first natural fish passage barriers on the North and South Forks of Battle Creek, and the confluence of Battle Creek with the Sacramento River. The first natural impassable barrier on the North Fork is an unnamed feature approximately 14 miles upstream from the confluence of the North and South forks. The first natural impassable barrier on the South Fork is known as Angel Falls, and is located approximately 6 miles upstream from the South Diversion Dam (NMFS 2005).

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species (Evolutionarily Significant Units (ESU) or Distinct Population Segments (DPS)) and designated critical habitat occur in the action area and may be affected by continued PG&E operations:

Southern Resident killer whale DPS
(*Orcinus orca*), endangered (November 18, 2005, 70 FR 69903)
Sacramento River winter-run Chinook salmon ESU
(*Oncorhynchus tshawytscha*) endangered (June 28, 2005, 70 FR 37160)
Central Valley spring-run Chinook salmon ESU
(*Oncorhynchus tshawytscha*) threatened (June 28, 2005, 70 FR 37160)
Central Valley spring-run Chinook salmon designated critical habitat
(September 2, 2005, 70 FR 52488)
Central Valley steelhead DPS
(*Oncorhynchus mykiss*) threatened (signed December 22, 2005)
Central Valley steelhead designated critical habitat
(September 2, 2005, 70 FR 52488)

The threatened Southern DPS of North American green sturgeon (*Acipenser medirostris*) is not found in Battle Creek and therefore will not be affected by the proposed project.

A. Species Life History, Population Dynamics, and Likelihood of Survival

1. <u>Southern Resident Killer Whales</u>

The Southern Resident killer whale DPS (Southern Residents) was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). Southern Residents are found throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as the Queen Charlotte Islands, British Columbia. Recent sightings in Oregon (in 1999 and 2000) and California (in 2000, 2003, 2005, 2006 and 2008) have considerably extended the southern limit of their known range (NMFS 2008).

Several potential factors identified in the final recovery plan for Southern Residents may have caused the decline or may be limiting recovery of the DPS. These are: quantity and quality of prey; toxic chemicals, which accumulate in top predators; and disturbance from sound and vessel effects. Oil spills are also a potential risk factor for this species. Research has yet to identify which threats are most significant to the survival and recovery of Southern Residents. It is likely that multiple threats are acting in concert to impact the whales.

Southern Resident killer whales are affected by the proposed action because whale populations depend on adequate prey levels, and, based on a long-term study of resident killer whale diet (Ford and Ellis 2006), Chinook salmon can comprise up to 72 percent of their prey consumed during spring, summer and fall.

The proposed project is expected to result in minor impacts to Central Valley Chinook salmon populations, and as a result these minor impacts would not be expected to result in an appreciable reduction in the overall prey base for Southern Residents. This is apparent considering the run size of Chinook in the Restoration Project area in Battle Creek (past 9 year average of 120 - compared to an approximate average of 466,633 total Chinook for the Central Valley), adding in Chinook salmon from the Klamath, Columbian, and other basins in California, which indicates impacts (due to the Restoration Project) to the prey base are minor. Therefore, any potential effects from the proposed project on Southern Residents are expected to be insignificant, and would not be expected to reach a level where they could result in the take of this species. More detail about prey based effects on Southern Resident killer whales from effects on Central Valley Chinook salmon fisheries are analyzed in detail in the OCAP ESA section 7 consultation. NMFS concludes that the proposed project is not likely to adversely affect endangered Southern Resident killer whales, and this species will not be addressed further in this biological opinion.

2. Chinook Salmon

Chinook salmon are anadromous and the largest member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Eschmeyer *et al.* 1983, Page and Burr 1991). Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). "Stream-type" Chinook salmon enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over the summer, spawn in the fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in the winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Information on the migration rates of adult Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin, where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter and Sanford 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter and Sanford (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion, several days at a time, while migrating upstream [California Bay-Delta Program (CALFED) 2001]. Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook salmon, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations, meaning that they are primarily active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates showed peak upstream movement of adult Central Valley spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the 4-hour period before sunrise and again after sunset (Johnson et al. 2009).

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools [U.S. Fish and Wildlife Service (USFWS) 1995]. Upon emergence, fry swim or are displaced downstream (Healey 1991). Similar to adult movement, juvenile salmonid downstream movement is crepuscular. Documents and data provided to NMFS in support of ESA section 10 research permit applications depict that the daily migration of juveniles passing RBDD is highest in the 4-hour period prior to sunrise (*e.g.*, Martin *et al.* 2001). Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in the stream for a period of time from weeks to a year (Healey 1991).

Fry then seek nearshore habitats containing riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996). The benefits of shallow water habitats for salmonid rearing have been found to be more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001).

As juvenile Chinook salmon grow, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile salmon in the Sacramento River near West Sacramento exhibited larger-sized juveniles captured in the main channel and smaller-sized fry along the margins (USFWS 1997). When the river channel is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1980). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration (Kjelson *et al.* 1982, Brandes and McLain 2001).

Juvenile Chinook salmon migration rates vary considerably, presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found fry Chinook salmon to travel as fast as 30 km per day in the Sacramento River and Sommer *et al.* (2001) found rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally-influenced sandy beaches and vegetated zones (Meyer 1979, Healey 1980). Cladocerans, copepods, amphipods, and diptera larvae, as well as small arachnids and ants, are common prey items (Kjelson *et al.* 1982, MacFarlane and Norton 2001, Sommer *et al.* 2001).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1981, Healey 1991). Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Juvenile Chinook salmon were found to spend about 40 days migrating through the Sacramento-San Joaquin Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallone Islands (MacFarlane and Norton 2001). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon), MacFarlane and Norton (2001) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

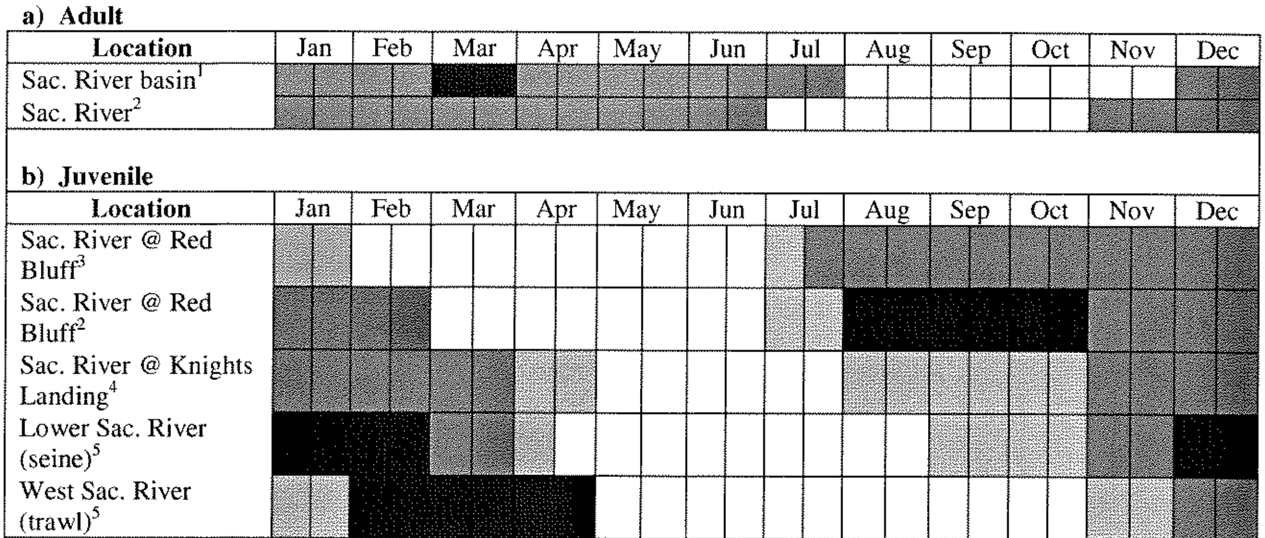
a. Sacramento River Winter-Run Chinook Salmon

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. NMFS reaffirmed the listing of Sacramento River winter-run Chinook salmon as endangered on June 28, 2005 (70 FR 37160). The ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. The Livingston Stone National Fish Hatchery population has been included in the listed Sacramento River winter-run Chinook salmon ESU (June 28, 2005, 70 FR 37160). NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212).

Sacramento River winter-run Chinook salmon adults enter the Sacramento River basin between December and July, the peak occurring in March (Table 3; Yoshiyama *et al.* 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and RBDD (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old.

Emigration of juvenile Sacramento River winter-run Chinook salmon past RBDD may begin as early as mid July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991). From 1995 to 1999, all Sacramento River winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile Sacramento River winter-run Chinook salmon occur in the Delta primarily from November through early May, based on data collected from trawls in the Sacramento River at West Sacramento [river mile (RM) 57, USFWS 2001]. The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continuing through May (Fisher 1994, Myers *et al.* 1998).

Table 3. The temporal occurrence of adult (a) and juvenile (b) Sacramento River winter-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.



Source: [1]Yoshiyama *et al.* 1998; Moyle 2002; [2]Myers *et al.* 1998; [3]Martin *et al.* 2001; [4]Snider and Titus 2000; [5]USFWS 2001a

Relative Abundance: ■ = High ■ = Medium ■ = Low

Historical Sacramento River winter-run Chinook salmon population estimates were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). In recent years, the carcass survey population estimates of winter-run Chinook salmon were 8,218 in 2003, 7,869 in 2004, 15,839 in 2005, 17,304 in 2006 (CDFG 2008), which show a recent increase in the population size and a 4-year average of 12,315. The 2006 run was the highest since the listing. However, the population estimate for winter-run Chinook salmon in 2007 was only 2,542, and the preliminary population estimate was only 2,850 in 2008 (CDFG 2009). The ocean life history traits and habitat requirements of juvenile winter-run Chinook salmon and fall-run Chinook salmon are similar. Therefore, the unusual and poor ocean conditions that caused the drastic decline in returning fall run Chinook salmon populations coast wide in 2007 (Varanasi and Bartoo 2008) are suspected to have also caused the observed decrease in the winter-run Chinook salmon spawning population in 2007 (Oppenheim 2008). Two current methods are utilized to estimate the juvenile production of Sacramento River winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress 2004). Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at RBDD to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, Gaines and Poytress (2004) estimated an average of 3,857,036 juveniles exiting in the upper Sacramento River at RBDD between the years of 1996 and 2003. Averaging these 2 estimates yields an estimated population size of 3,782,476 juveniles during that time frame.

Based on RBDD counts, the population has been growing rapidly since the 1990s with positive short-term trends. An age-structured density-independent model of spawning escapement by

Botsford and Brittnacher (1998) assessing the viability of Sacramento River winter-run Chinook salmon found the species was certain to fall below the quasi-extinction threshold of 3 consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures. They found a biologically significant expected quasi-extinction probability of 28 percent. There is only one population of Sacramento River winter-run Chinook salmon, which depends on cold-water releases from Shasta Dam, and could be vulnerable to a prolonged drought (Good *et al.* 2005).

Lindley *et al.* (2007), in their framework for assessing the viability of Chinook salmon and steelhead in the Sacramento-San Joaquin River basin, concluded that the population of winter-run Chinook salmon that spawns below Keswick Dam satisfies low-risk criteria for population size and population decline, but increasing hatchery influence is a concern that puts the population at a moderate risk of extinction. Furthermore, Lindley *et al.* (2007) pointed out that an ESU represented by a single population at moderate risk is at a high risk of extinction over the long term.

Population estimates from 2001 through 2004 show relatively consistent population levels with at least 4,000 more adults than any of the previous 15 years (Table 4). The 2006 run (17,304 fish) was the highest since listing. Also, there was an increasing trend in the five-year moving average (491 from 1990-1994 to 9,530 from 2000-2005), as well as the five-year moving average of cohort replacement rate. However, over the past two years numbers have gone down to 2,542 in 2007 and 2,850 in 2008.

Table 4. Winter-run Chinook salmon population estimates from Red Bluff Diversion Dam counts, and corresponding cohort replacement rates for the years since 1986. (CDFG 2009)

Year	Population Estimate (RBDD)	5 Year Moving Average Population Estimate	Cohort Replacement Rate	5 Year Moving Average of Cohort Replacement Rate
1986	2596	-	-	-
1987	2186	-	-	-
1988	2885	-	-	-
1989	696	-	0.27	-
1990	430	1759	0.20	-
1991	211	1282	0.07	-
1992	1240	1092	1.78	-
1993	387	593	0.90	0.64
1994	186	491	0.88	0.77
1995	1297	664	1.05	0.94
1996	1337	889	3.45	1.61
1997	880	817	4.73	2.20
1998	2992	1338	2.31	2.48
1999	3288	1959	2.46	2.80
2000	1352	1970	1.54	2.90
2001	8224	3347	2.75	2.76
2002	7464	4664	2.27	2.26
2003	8218	5709	6.08	3.02
2004	7869	6625	0.96	2.72
2005	15875	9530	2.13	2.84
2006	17304	11346	2.11	2.71
2007	2542	10362	0.32	2.32
2008	2850	9288	0.18	1.14

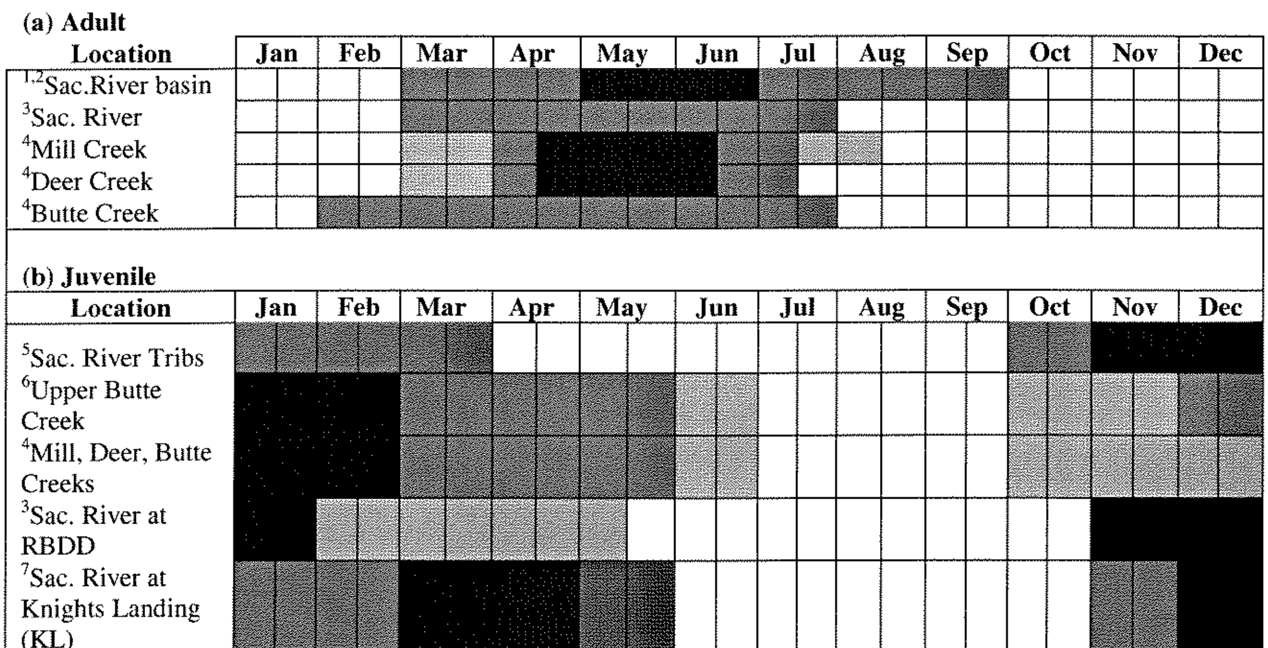
b. *Central Valley Spring-Run Chinook Salmon*

NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened on September 16, 1999 (64 FR 50394). In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). This proposal was based on the recognition that although Central Valley spring-run Chinook salmon productivity trends are positive, the ESU continues to face risks from having a limited number of remaining populations (*i.e.*, 3 existing populations from an estimated 17 historical populations), a limited geographic distribution, and potential hybridization with Feather River Hatchery (FRH) spring-run Chinook salmon, which until recently were not included in the ESU and are genetically divergent from other populations in Mill, Deer, and Butte Creeks. On June 28, 2005 (70 FR 37160), after reviewing the best available scientific and commercial information, NMFS issued its final rule to retain the status of Central Valley spring-run Chinook salmon as threatened. This decision also included the FRH spring-run Chinook salmon population as part of the Central Valley spring-run

Chinook salmon ESU. Critical habitat was designated for Central Valley spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (table 5, Yoshiyama *et al.* 1998, Moyle 2002). Lindley *et al.* (2006) indicated that adult Central Valley spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid April and mid June. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering, while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Table 5. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.



Source:[1]Yoshiyama *et al.* 1998; [2]Moyle 2002; [3]Myers *et al.* 1998; [4]Lindley *et al.* 2007; [5]CDFG 1998; [6]McReynolds *et al.* 2005; Ward *et al.* 2002, 2003; [7]Snider and Titus 2000

Relative Abundance: = High = Medium = Low

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002), and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year (YOY), juveniles, or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer Creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2006). Studies in Butte Creek (Ward *et al.* 2002, 2003; McReynolds *et al.* 2005) found the majority of Central Valley spring-run Chinook salmon migrants to be fry occurring primarily during December through February, and that these movements appeared to be influenced by flow. Small numbers of Central Valley spring-run

Chinook salmon remained in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer Creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer Creek juveniles typically exhibit a later YOY migration and an earlier yearling migration (Lindley *et al.* 2006).

Once juveniles emerge from the gravel, they seek areas of shallow water and low velocities while they finish absorbing the yolk sac (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case of other salmonids, there is a shift in microhabitat use by juveniles to deeper, faster water as they grow. Microhabitat use can be influenced by the presence of predators, which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). Peak movement of juvenile Central Valley spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to FRH. In 2002, FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run and fall-run Chinook salmon are spawned together, thus compromising the genetic integrity of the spring-run and early fall-run Chinook salmon stocks. The number of naturally-spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap with fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

The Central Valley spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance, ranging from 1,403 in 1993 to 25,890 in 1982. The average abundance for the ESU was 12,590 for the period of 1969 to 1979, 13,334 for the period of 1980 to 1990, 6,554 from 1991 to 2001, and 16,349 between 2002 and 2005 (Pacific Fishery Management Council 2004; CDFG 2004, 2006; Yoshiyama *et al.* 1998). Finally, for the period of 2006 to 2008 the average abundance for the ESU fell to a low of 854 (CDFG 2009). Sacramento River tributary populations in Mill, Deer, and Butte Creeks are probably the best trend indicators for the Central Valley spring-run Chinook ESU as a whole because these streams contain the primary independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish since 1995 (until 2005). During this same period, adult returns on Mill Creek have averaged 778 fish, and 1,463 fish on Deer Creek. Although recent trends had been positive, annual abundance estimates display a high level of fluctuation, and the overall number of Central Valley spring-run Chinook salmon remains well below estimates of historic abundance. Additionally, in 2003, high water temperatures, high fish densities, and an outbreak of Columnaris Disease (*Flexibacter columnaris*) and Ichthyophthiriasis

(*Ichthyophthirius multifiis*) contributed to the pre-spawning mortality of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek. Most recently, returns on Butte, Mill and Deer creeks have been the lowest since prior to 2000, with the 2008 estimate on Butte Creek at 3,935, 362 on Mill Creek and 140 on Deer Creek.

Lindley *et al.* (2006) concluded that Butte and Deer Creek spring-run Chinook salmon are at low risk of extinction, satisfying viability criteria for population size, growth rate, hatchery influence, and catastrophe. The Mill Creek population is at a low to moderate risk, satisfying some, but not all viability criteria. The Feather and Yuba River populations are data deficient and were not assessed for viability. However, because the existing Central Valley spring-run Chinook salmon populations are spatially confined to relatively few remaining streams in only one of four historic diversity groups, the ESU remains vulnerable to catastrophic disturbance, and remains at a moderate to high risk of extinction.

3. Central Valley Steelhead

Central Valley steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin River basins in California's Central Valley. In June 2004, NMFS proposed that Central Valley spring-run Chinook salmon remain listed as threatened (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of Central Valley steelhead as threatened (70 FR 37160). This decision also included the Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for Central Valley steelhead on September 2, 2005 (70 FR 52488).

Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead are currently found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s [Interagency Ecological Program (IEP) Steelhead Project Work Team 1999]. At present, summer steelhead are found only in northern California coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Central Valley steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April, with peaks from January through March, in small streams and tributaries where cool, well oxygenated water is available year-round (table 6, Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly-emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although YOY also are abundant in glides and riffles. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Some juvenile steelhead may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) have also verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 (mean 200,000) smolts emigrate to the ocean per year, representing approximately 3,600 female Central Valley steelhead spawners in the Central Valley basin (Good *et al.* 2005). This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s.

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks, and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Recent snorkel surveys (1999 to 2008) indicate that steelhead are present in Clear Creek (Giovannetti *et al.* 2008, Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. However, recent monitoring has detected small, self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras Rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000).

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles have also occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005). CDFG staff have prepared juvenile migrant Central Valley steelhead catch summaries on the San Joaquin River near Mossdale, representing migrants from the Stanislaus, Tuolumne, and Merced Rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG (2003) stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River." The documented returns on the order of single fish in these tributaries suggest that existing populations of Central Valley steelhead on the Tuolumne, Merced, and lower San Joaquin Rivers are severely depressed

Lindley *et al.* (2006a) indicated that prior population census estimates completed in the 1990s found the Central Valley steelhead spawning population above RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing, as evidenced by new information (Chipps Island trawl data). Central Valley steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of Central Valley steelhead is uncertain due to limited data concerning their status. However, Lindley *et al.* (2007) concluded that there is sufficient evidence to suggest that the ESU is at moderate to high risk of extinction.

Table 6. The temporal occurrence of adult (a) and juvenile (b) Central Valley steelhead in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,3]Sac. River	L / L	L / L	L / L	– / –	– / –	– / L	L / L	L / M	M / H	H / M	L / L	L / L
[2,3]Sac R at Red Bluff	L / L	L / L	L / L	L / L	L / L	L / L	L / L	L / L	M / M	H / M	L / L	L / L
[4]Mill, Deer Creeks	– / –	H / M	M / L	L / L	L / L	L / L	– / –	– / –	– / –	– / H	H / M	M / M
[6]Sac R. at Fremont Weir	L / L	L / L	– / –	– / –	– / –	– / –	– / –	M / M	H / H	M / M	L / L	L / L
[6]Sac R. at Fremont Weir	L / L	L / L	– / –	– / –	– / –	– / –	– / –	M / M	H / H	M / M	L / L	L / L
[7]San Joaquin River	– / –	– / –	– / –	– / –	– / –	– / –	L / L	L / L	M / M	M / M	M / M	H / H

(b) Juvenile

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sacramento River	L / L	L / L	M / M	M / M	M / M	M / M	L / L	L / L	L / L	M / M	M / M	L / L
[2,8]Sac. R at Knights Land	L / L	L / L	H / H	L / L	L / –	– / –	– / –	– / –	– / –	– / –	– / –	– / L
[9]Sac. River @ KL	M / M	M / M	H / H	H / H	M / M	– / –	– / –	– / –	– / –	– / –	L / L	L / L
[10]Chipps Island (wild)	L / L	L / L	H / H	H / H	M / M	M / M	L / L	– / –	– / –	L / L	L / L	L / L
[8]Mossdale	– / –	– / –	– / –	H / H	H / H	– / –	– / –	– / –	– / –	– / –	– / –	– / –
[11]Woodbridge Dam	M / M	M / M	M / M	M / M	M / M	M / M	M / M	– / –	– / –	– / –	– / –	– / –
[12]Stan R. at Caswell	L / L	M / M	H / H	M / M	M / M	M / L	– / –	– / –	– / –	– / –	– / –	– / –
[13]Sac R. at Hood	L / L	H / H	H / H	H / H	H / H	H / H	– / –	– / –	– / –	– / –	L / L	L / L

Source: [1]Hallock 1961; [2]McEwan 2001; [3]USFWS unpublished data; [4]CDFG 1995; [5]Hallock et al. 1957; [6]Bailey 1954;
[7]CDFG Steelhead Report Card Data; [8]CDFG unpublished data; [9]Snider and Titus 2000;
[10]Nobriga and Cadrett 2003; [11]Jones & Stokes Associates, Inc., 2002; [12]S.P. Cramer and Associates, Inc. 2000; [13]Schaffter 1980.

Relative Abundance: H = High M = Medium L = Low

B. Critical Habitat and Primary Constituent Elements for Listed Salmonids

The designated critical habitat for Sacramento River winter-run Chinook salmon includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Estuary to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge. In the Sacramento River, critical habitat includes the river water column, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. In the areas westward of Chipps Island, critical habitat includes the estuarine water column and essential foraging habitat and food resources used by Sacramento River winter-run Chinook salmon as part of their juvenile emigration or adult spawning migration.

Critical habitat for Central Valley spring-run Chinook salmon includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River and Delta. Critical habitat for Central Valley steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; and, the San Joaquin River its tributaries, and the Delta.

Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (September 2, 2005, 70 FR 52488). The bankfull elevation is defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (Dunne and Leopold 1978, MacDonald *et al.* 1991, Rosgen 1996). Critical habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead is defined as specific areas that contain the primary constituent elements (PCE) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for Central Valley spring-run Chinook salmon and Central Valley steelhead, and as physical habitat elements for Sacramento River winter-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon and steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily between RBDD and Keswick Dam. Central Valley spring-run Chinook salmon also spawn in the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte Creeks. Spawning habitat for Central Valley steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams throughout the Central Valley. Most remaining natural spawning habitats (those not downstream from large dams) are currently in good condition, with adequate water temperatures, stream flows, and gravel conditions to support successful reproduction. Some areas below dams, especially for steelhead, are degraded by fluctuating flow conditions related to water storage and flood management that scour or strand redds. Regardless of its current condition, spawning habitat in general has a high intrinsic value, as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover, such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries may also be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system [*e.g.*, the lower Cosumnes River, Sacramento River reaches with set-back levees (*i.e.*, primarily located upstream of the City of Colusa)]. However, the channeled, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high intrinsic value to salmonids, as the juvenile life stages are dependant on the function of this habitat for successful survival and recruitment. Thus, although much of the rearing habitat is in poor condition, it is important to the species.

3. <u>Freshwater Migration Corridors</u>

Ideal freshwater migration corridors are free of obstruction with water quantity and quality conditions and contain natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility, survival and food supply. Migratory corridors are downstream of the spawning area and include the lower Sacramento River and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly-screened diversions, and degraded water quality. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, but problems exist on many tributary streams, and at the RBDD. For juveniles, unscreened or inadequately screen water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic value to the species.

4. <u>Estuarine Areas</u>

Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover, such as submerged and overhanging large wood, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high intrinsic value because they function as rearing habitat and as an area of transition to the ocean environment.

C. Factors Affecting Listed Species and Critical Habitat

California's robust agricultural economy and rapidly increasing urban growth place high demand for water in the Sacramento and San Joaquin River basins. The demand for water in the Central

Valley has significantly altered the natural morphology and hydrology of the Sacramento and San Joaquin Rivers and their major tributaries. Agricultural lands and urban areas have flourished on historic floodplains. An extensive flood management system of dams, levees, and bypass channels restricts the river's natural sinuosity, volume, and reduces the lag time of water flowing through the system. An impressive network of water delivery systems have transformed the Central Valley drainage system into a series of lined conveyance channels and reservoirs that are operated by several pumping facilities. Flood management and water delivery systems, in addition to agricultural, grazing, and urban land uses, are the main anthropogenic factors affecting watersheds in the action area.

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley (*e.g.*, Busby *et al.* 1996, Myers *et al.* 1998, Good *et al.* 2005, CALFED 2000). NMFS has also assessed the factors contributing to Chinook salmon and steelhead decline in supplemental documents (NMFS 1996, 1998) and Federal Register notices (*e.g.*, June 16, 1993, 58 FR 33212; January 4, 1994, 59 FR 440; May 6, 1997, 62 FR 24588; August 18, 1997, 62 FR 43937; March 19, 1998, 63 FR 13347; May 5, 1999, 64 FR 24049; September 16, 1999, 64 FR 50394; February 16, 2000, 65 FR 7764). The foremost reason for the decline in these anadromous salmonid populations is the degradation and/or destruction of habitat (*e.g.*, substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, and migration conditions). Additional factors contributing to the decline of these populations include: over-utilization, disease or predation, the inadequacy of existing regulatory mechanisms, and other natural and manmade factors including global climate change. All of these factors have contributed to the ESA-listing of these fish and deterioration of their critical habitats. However, it is widely recognized in numerous species accounts in the peer-reviewed literature that the modification and curtailment of habitat and range have had the most substantial impacts on the abundance, distribution, population growth, and diversity of salmonid ESUs and DPSs. Although habitat and ecosystem restoration has contributed to recent improvements in habitat conditions throughout the ESUs/DPSs, global climate change remains a looming threat.

1. Modification and Curtailment of Habitat and Range

Modification and curtailment of habitat and range from hydropower, flood control, and consumptive water use have permanently blocked or hindered salmonid access to historical spawning and rearing grounds, resulting in the complete loss of substantial portions of spawning, rearing, and migration PCEs. Clark (1929) estimated that there were originally 6,000 linear miles of salmon habitat in the Central Valley system, and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today. Yoshiyama *et al.* (1996) surmised that steelhead habitat loss was even greater than salmon loss, as steelhead migrated farther into drainages. In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and the Delta block salmon and steelhead access to the upper portions of their respective watersheds. The loss of upstream habitat had required Chinook salmon and steelhead to use less hospitable reaches below dams. The loss of substantial habitat above dams also has resulted in decreased juvenile and adult steelhead survival during migration, and in many cases, had resulted in the dewatering and loss of important spawning and rearing habitats.

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in stream flows and diversions of water affect spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and instream woody material. More uniform flows year-round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement, caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams.

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al.* 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). High water temperatures in the Sacramento River have limited the survival of young salmon.

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects that have diminished conditions for adult and juvenile migration and survival.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization and riprapping include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al.* 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996). Large woody debris influences channel morphology by affecting longitudinal profile, pool formation, channel pattern and position, and channel geometry. Downstream transport rates of sediment and organic matter are controlled in part by storage of this material behind large wood. Large wood affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (NMFS 1996). Wood enters streams inhabited by salmonids either directly from adjacent riparian zones or from riparian zones in adjacent non-fish bearing tributaries. Removal of riparian vegetation and instream woody material from the streambank results in the loss of a primary source of overhead and instream cover for juvenile salmonids. The removal of riparian vegetation and instream woody material and the replacement of natural bank substrates with rock revetment can adversely affect important ecosystem functions. Living space and food for terrestrial and aquatic invertebrates is lost, eliminating an important food source for juvenile salmonids. Loss of riparian vegetation and soft substrates reduces inputs of organic material to the stream ecosystem in the form of leaves, detritus, and woody debris, which can affect biological production at all trophic levels.

In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney *et al.* 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases affecting salmonid food supply.

2. Ecosystem Restoration

The Central Valley Project Improvement Act (CVPIA), implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the Central Valley Project. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward doubling the natural populations of select anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the Department of the Interior's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the Environmental Water Account, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids, and emphasis has been placed in tributary drainages with high potential for Central Valley steelhead and spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CALFED-ERP have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids.

The California Department of Water Resources' (CDWR) Four Pumps Agreement Program has approved approximately $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement's inception in 1986. Four Pumps projects that benefit Central Valley spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Estuary upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Additionally, predator habitat isolation and removal and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead.

3. Natural Fluctuations in Ocean Conditions and Global Climate Change

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al.* 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale ocean temperature shifts, such as El Niño, appear to change ocean productivity, and can have significant effects on rainfall in the Central Valley

Another key factor affecting many West Coast fish stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. NMFS presumes that survival is driven largely by events occurring between ocean entry and recruitment to a subadult life stage. One indicator of early ocean survival can be computed as a ratio of CWT recoveries from subadults relative to the number of CWTs released from that brood year.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Ocean predation may also contribute to significant natural mortality, although to what degree is not known. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations—following their protection under the Marine Mammal Protection Act of 1972—has substantially increased salmonid mortality.

Finally, the unusual drought conditions in 2001 warrant additional consideration. Flows in 2001 were among the lowest flow conditions on record. The available water in the Sacramento and San Joaquin River watersheds was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. The juveniles that passed downriver during the 2001 spring and summer out migration were likely affected, and this, in turn, likely affected adult returns primarily in 2003 and 2004, depending on the stock and species.

a. *Global Climate Change*

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change 2001). Much of that increase will likely occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data, Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

An alarming prediction is the fact that Sierra snow packs are expected to decrease with global warming and that the majority of runoff in California will be from rainfall in the winter rather than from melting snow pack in the mountains (CDWR 2006). This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt-dominated system to a winter rain dominated system. This would likely truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold-water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could rise above thermal tolerances for juvenile and adult salmonids (*e.g.*, Sacramento River winter-run Chinook salmon and Central Valley steelhead) that must hold below Keswick Dam over the summer and fall periods.

4. Critical Habitat for Salmonids

According to NMFS' (2005b) Critical Habitat Analytical Review Team (CHART) report, the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals, (2) channel modifications and levee maintenance, (3) the presence and operation of hydroelectric dams, (4) flood control and streambank stabilization, and (5) exotic and invasive species introductions and management. All of these activities affect PCEs via their alteration of one or more of the following: stream hydrology, flow and water-level modification, fish passage, geomorphology and sediment transport, temperature, DO levels, nearshore and aquatic vegetation, soils and nutrients, physical habitat structure and complexity, forage, and predation (Spence *et al.* 1996). According to the CHART report (NMFS 2005b), the condition of critical habitat varies throughout the range of the species. Generally, the conservation value of existing spawning habitat ranges from moderate to high quality, with the primary threats including changes to water quality, and spawning gravel composition from rural, suburban, and urban development, forestry, and road construction and maintenance. Downstream, river and estuarine migration and rearing corridors range in condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversion, small dams, and water quality. Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin River reaches tended to range from poor to high quality, depending on location. In the alluvial reach of the Sacramento River between Red Bluff and Colusa, the PCEs of rearing and migration habitat are in good condition because, despite the influence of upstream dams, this reach retains natural, and functional channel processes that maintain and develop anadromous fish habitat. The river reach downstream from Colusa and including the Delta is poor in quality due to impaired hydrologic conditions from dam operations, water quality from agriculture, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species within the action area. The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR § 402.02).

The Battle Creek Watershed is in the Cascade Range foothill physiographic region (Hickman 1993). The Cascade region's geology is derived from the volcanic formations created by Mount Lassen and its predecessor volcanoes. The volcanic formations produce a type of hydrology that is unusual for the Central Valley, characterized by abundant cold water from spring flows and relatively high dry-season base flows.

Battle Creek is a tributary to the upper Sacramento River and is one of the only watersheds of significant size remaining in the Cascade region that is accessible to anadromous salmonids. It also has habitat types similar to those in which the now scarce runs of winter- and spring-run Chinook salmon evolved (FWS 1995a). Prior to the hydroelectric development in Battle Creek watershed more than a century ago, prime habitat for Chinook salmon and steelhead extended from the confluence with the Sacramento River upstream to natural barrier waterfalls on North Fork and South Fork Battle Creek.

Battle Creek is a high-gradient, headwater stream with an elevation change in excess of 5,000 ft over 50 miles. The creek flows through remote, deep, shaded canyons and riparian corridors with little development near its banks. The Battle Creek channel is characterized by alternating pools and riffles. Boulders, ledges, and turbulence provide diversity to the channel form. Substrate size ranges from sand to boulder with predominantly gravel and cobble throughout the system. Concentration and types of gravel deposits are directly correlated to stream gradient. Sediment mobility studies imply that gravel in Battle Creek moves with enough frequency to keep it clean of fine sediment and loose enough to support spawning by Chinook salmon and steelhead (Reclamation 2001).

Battle Creek flows have been diverted for hydroelectric development, irrigation, and hatchery operations (U.S. Fish and Wildlife Service 2001). Flows vary seasonally and range from 30 cfs in August to 8,000 to 20,000 cfs during spring. The current anadromous habitat in the Battle Creek watershed is strongly influenced by the Hydroelectric Project, which consists of five powerhouses, two small storage reservoirs, three forebays, five diversions on the North Fork Battle Creek, three diversions on the South Fork Battle Creek, numerous tributary and spring diversions, and a network of some 16 canals, ditches, flumes, and a pipeline. Small feeder dams divert water from secondary streams into the projects canals. The Ripley and Soap Creek feeders divert additional tributary water into the Inskip and South Canal, respectively. The Asbury Diversion Dam feeds water into the Coleman Canal on Baldwin Creek. Dam construction and operations had extirpated most of the original salmonid populations in Battle Creek by the early 1900s, and continue to have an impact on salmon and steelhead by limiting their habitat and availability of water during high water demands (NMFS 2006).

In addition to the barriers to be addressed by the Restoration Project, Coleman National Fish Hatchery (CNFH) operates a barrier weir along with a fish ladder 5.5 miles upstream of Battle Creek's confluence with the Sacramento River (U.S. Fish and Wildlife Service 2001). The fish ladder at CNFH was designed to pass 40 cfs of water to meet flow criteria during the dry season when fall-run Chinook are migrating. Prior to modification, fish were able to pass over the CNFH barrier weir (when the ladders were closed) into upper Battle Creek when laminar flows greater than 350 cfs occurred over the apron of the barrier weir (NMFS 2006). The fish ladder and weir were modified in 2007–2008. A new ladder structure containing two forks, one leading directly to the existing CNFH adult holding ponds and the second providing access to Battle Creek upstream of the barrier weir, was constructed. The new flow criteria provide up to 300 cfs total flow (ladder flow capacity plus attraction flow). These design criteria and modifications to the ladder provide acceptable fish passage conditions at creek flows up to 3,000 cfs, the flow at which the stream overflows its banks (Hamelberg pers. comm.). The existing barrier weir was modified by adding a 2-foot-wide lipped crest cap and a 10.5-foot overshot gate. The crest cap provides 100% blockage to upstream migrating salmonids at flows up to 800 cfs (Hamelberg pers. comm.). The objectives of management of the fish ladder currently are to:

- prevent large numbers of hatchery origin Chinook salmon and steelhead from accessing upper Battle Creek and overwhelming the remaining natural stocks in that area.
- minimize the potential for hybridization between co-occurring, naturally reproducing runs of Chinook salmon in Battle Creek upstream of the barrier weir; and
- monitor passage of salmonids (Jones & Stokes 2005).

When the fish ladder is closed, the barrier weir obstructs passage of adult steelhead and Chinook salmon to Battle Creek above the hatchery. Adult escapement data, provided by the USFWS, are from the fish trapping in the upstream ladder of the CNFH barrier weir. The fish trap in the upstream fish ladder is monitored between approximately March 1 and August 1. Between March 1 and approximately late May, fish are trapped and directly handled and counted. Between approximately early June and August 1, fish are counted using videography. Beginning on August 1, current Battle Creek fishery management protocol calls for closure of the barrier weir ladder. Although the upstream fish ladder remains closed until March, monitoring begins again about the first of October as adults are handled for broodstock collection and spawning purposes at CNFH (Reclamation 2007).

A. Status of the Listed Species and Critical Habitat within the Action Area

1. Sacramento River Winter-Run Chinook Salmon

Winter-run Chinook salmon are indigenous to Battle Creek (Kier Associates 1999). However, no reliable records exist that document the size of the population prior to 1995. Historically, systematic counts of adult winter-run Chinook salmon had not been made because of unfavorable environmental conditions during the high-flow winter months when these fish migrate upstream.

The occurrence of successfully reproducing winter-run Chinook salmon in Battle Creek was first documented in 1898 and again in 1900, when the U.S. Fish Commission collected salmon fry in specially-designed nets (Rutter 1904). Small, newly-emerged salmon fry (of a size that could only have been winter-run Chinook salmon) were captured in Battle Creek in September and early October (Rutter 1904; FWS 1992).

A spawning run of adult winter-run Chinook salmon in Battle Creek was documented during the late 1940s and early 1950s, when the CNFH began late fall-run Chinook salmon egg-taking operations (FWS 1987). From the 1950s to the early 1960s, CDFG reported the existence of winter-run Chinook salmon in Battle Creek during a statewide inventory of steelhead and salmon resources, but provided no estimate of the size of the population in Battle Creek (CDFG 1965). The CNFH trapped winter-run Chinook salmon in Battle Creek during the late 1950s, including 309 winter-run Chinook salmon in 1958 (FWS 1963), suggesting that winter-run Chinook salmon populations in Battle Creek reached a level of at least 300 adults during this period. Documentation of 24 adult winter-run Chinook salmon in South Fork Battle Creek in 1965 (CDFG 1966) indicates that winter-run Chinook salmon populations persisted in Battle Creek during the mid-1960s. No records exist that document the size of winter-run Chinook salmon populations in Battle Creek from the mid-1960s to the mid-1990s.

Since 1995, as part of its brood stock collection efforts, FWS has counted winter-run Chinook salmon in Battle Creek at the CNFH during the September-through-February portion of the winter-run Chinook salmon migration period. Winter-run Chinook salmon are also counted from March through June at the CNFH barrier weir, using trapping and videography. Altogether, these monitoring techniques account for most of the December-to-August spawning and migration period of adult winter-run Chinook salmon. Additionally, snorkel surveys and juvenile outmigrant trapping have been conducted on Battle Creek during this time period.

Monitoring information derived from the methods described above, have indicated that hatchery-origin winter-run Chinook salmon from past artificial propagation efforts at the CNFH (FWS 1995a, 1996) have returned to Battle Creek. The catch of a small number of nonhatchery-origin winter-run Chinook salmon in 1998 (FWS 1998) and 2000 indicates that Battle Creek may still have supported a remnant population (fewer than 10 documented fish) of naturally produced winter-run Chinook salmon at that time.

Although extensive monitoring for both adult and juvenile winter-run Chinook salmon has been consistently conducted in Battle Creek since 2000, no evidence of adult spawning or natal juvenile rearing has been detected (FWS, unpublished data). Therefore, it is likely that there is no longer a viable, naturally-reproducing population of winter-run Chinook salmon in Battle Creek.

2. Sacramento River Winter-Run Chinook Salmon Designated Critical Habitat

Critical habitat for Sacramento River winter-run Chinook salmon was only designated within the Sacramento River and lower estuary areas, and not in any tributary streams. Therefore, there is no designated critical habitat within the action area.

3. Central Valley Spring-Run Chinook Salmon

Recent monitoring indicates that an average of 113 adult spring-run Chinook salmon have used Battle Creek for holding and spawning annually during the past several years, although these population estimates are not precise (USFWS unpublished data, 2009). Current populations of spring-run Chinook salmon appear to be severely depressed when compared to populations that existed in the 1940s and 1950s.

At the beginning of CNFH operations, the hatchery collected 227, 1,181, 468, and 2,450 spring-run Chinook salmon from Battle Creek each year from 1943 to 1946, respectively, indicating that a relatively large population was present in the creek (FWS 1949). From 1952 to 1956, annual estimates of adult spring-run Chinook salmon in Battle Creek ranged from 1,700 to 2,200 (CDFG 1961).

Stream surveys in the early 1960s indicated that spring-run Chinook salmon utilized various areas of the Restoration project area including Eagle Canyon and South Fork Battle Creek upstream of Panther Creek, but these studies did not provide population estimates (CDFG 1966; Tehama County Community Development Group 1983). Spring-run Chinook salmon (*i.e.*, 40 to 50 adult fish) were again observed in Eagle Canyon in 1970, but no systematic population estimate was provided (CDFG 1970).

From 1995 to 1998, the FWS estimated the number of spring-run Chinook salmon located in holding habitat upstream of the CNFH barrier dam. These population estimates ranged from about 50 to 100 spring-run Chinook salmon (FWS 1996, 2000, 2002). From 1998 to 2001, the FWS counted Chinook salmon in Battle Creek during part of the spring-run Chinook salmon migration period. These partial counts indicate that perhaps as many as 71 to 100 spring-run Chinook salmon passed the CNFH barrier weir into the project area annually from 1998 to 2001. More recently full surveys have been conducted each year from 2002 through 2008 with an average of about 113 for estimated spring-run escapement (Newton 2008; and USFWS unpublished data, 2009).

4. Central Valley Spring-Run Chinook Salmon Critical Habitat

a. *Holding, Spawning, and Rearing Habitat*

The total estimated area of suitable spawning gravel in Battle Creek is 57,000 square feet in the mainstem above Coleman Powerhouse; 81,000 square feet in the North Fork up to the barrier waterfall; and 28,000 square feet in the South Fork up to Angel Falls (Payne and Associates

1994). Concentration and types of gravel deposits are directly correlated to stream gradient. Mobility studies imply that gravel in Battle Creek moves with enough frequency to keep it relatively free of fine sediment and loose enough to support spawning. The Battle Creek channel is characterized by alternating pools and riffles. The channel form, along with boulders, ledges, and turbulence, provides key elements of holding and rearing habitat for spring-run Chinook salmon.

b. *Migration Habitat*

Absolute natural barriers mark the terminus of anadromous salmonid habitat on North Fork and South Fork Battle Creek. In the steep, high-elevation stream reaches below these absolute barriers there are natural features in the channel, such as boulders and logs that can impede passage depending on vertical drop, flow depth, and flow velocity. Seven diversion dams block or impede passage of spring-run Chinook salmon and other fish species. A fish barrier at CNFH can also impede passage to varying degrees (depending on barrier weir operations) throughout the year.

c. *Contaminants*

Water samples were collected at eight sites in the Battle Creek Watershed and analyzed for metal, total suspended solids, and oil and grease (Reclamation 2004). The results revealed that each of these parameters was within the EPA's recommended levels for aquatic life. Contaminant levels in Battle Creek are relatively low and adverse effects are not documented.

5. Central Valley Steelhead

Operational records for CNFH provide information on the numbers of steelhead that have been passed upstream of the hatchery's barrier weir to spawn naturally in Battle Creek. Beginning in the early 1950s, an assumed mixture of hatchery and natural steelhead have been intermittently released above the barrier weir. Specifically, hatchery records from 1953 through 2004 document frequent releases of adults (from 100 to approximately 1,500 fish per year) above the CNFH barrier weir and it is likely that additional, undocumented releases also occurred (Campton *et al.* 2004). Releases of natural steelhead adults above the CNFH barrier weir have also occurred annually since 2004 (with a few hatchery steelhead passing during open ladder periods) to take advantage of increased instream flows resulting from interim flow agreements associated with the Restoration project (Table 7).

Prior to weir modification in 2007, steelhead in Battle Creek were able to jump over the CNFH barrier weir when the upstream fish ladder was closed, especially during periods of high flow. Monitoring of Central Valley fall-run Chinook salmon at the hatchery's barrier weir (prior to 2007) showed that escapement past the weir increased as flows exceed 350 cfs. Steelhead are generally considered to have superior leaping abilities compared to fall-run Chinook salmon and were therefore able to escape past the weir at lower flows and with greater frequency. During the principal period of steelhead migration in Battle Creek (October-February), average monthly flow ranges from 296 cfs in October to 727 cfs in February, suggesting that some escapement past the weir likely occurred throughout the timing of steelhead migration (Kier and Associates 1999). However, the number of uncounted steelhead that escaped past the weir is unknown.

When the fish ladders are open, it is believed that most steelhead use the ladders to travel upstream rather than attempting to jump over the barrier weir and are able to be counted (Campton *et al.* 2004).

The existing barrier was modified in 2007 to 2008 by adding a 2-foot-wide lipped crest cap and a 10.5-foot overshot gate. The crest cap provides 100% blockage to upstream migrating salmonids at flows up to 800 cfs (Hamelburg pers. Communication).

Table 7. Numbers of steelhead collected at CNFH and released above the barrier weir in Battle Creek, return years 1995 to 2008. Data shown in this table includes steelhead collected at the CNFH during broodstock collection operations and steelhead trapped or observed at the CNFH barrier weir after broodstock collection had ended (Campton *et al.* 2004; Newton 2008; USFWS unpublished data, 2009).

	Steelhead Released above the CNFH Barrier Weir		
Return Year	Ad-clipped (Hatchery)	No ad-clip (Natural)	Total
1995-1996			276[a]
1996-1997			295[a]
1997-1998			418[a]
1998-1999			1,163[a]
1999-2000			1,416[a]
2000-2001	1,382	225	1,483[b]
2001-2002	1,442	593	1,838
2002-2003	772	534	1,245
2003-2004	329	304	492[c]
2004-2005	0	344	344[d]
2005-2006	1	438	439[e]
2006-2007	3	346	349[e]
2007-2008	1	279	280[e]

a. A comprehensive marking program for juvenile steelhead produced at CNFH began in 1998, therefore, differentiation between natural and hatchery adults based on mark status was not entirely possible until the 2001-2002 return year.
b. During 1997 approximately 75 percent of the juvenile steelhead released from Coleman NFH were marked with an adipose fin clip resulting in age-3 hatchery adults being marked at a rate of 75 percent during 2000-2001.
c. 2003-2004 Data does not include steelhead collected after March 1, 2004.
d. Beginning return year 2004-2005 ad-clipped steelhead were no longer released upstream of the barrier weir.
e. The occasional ad-clipped steelhead in 2005-2006 to present passed upstream of the barrier weir during video monitoring (open passage)

6. Central Valley Steelhead Critical Habitat

The primary constituent elements of critical habitat for steelhead within the action area are nearly identical to those for spring-run Chinook salmon. Therefore, the status of critical habitat for steelhead can be considered the same as that provided above for spring-run Chinook salmon.

B. Factors Affecting Species and Critical Habitat Within the Action Area

The baseline factors discussed below can be assumed to affect all three species unless specifically otherwise stated in the text.

1. Hydroelectric Project Effects

a. *Migration Impacts at Dams and Natural Barriers*

The North Battle Creek Feeder, Eagle Canyon, Wildcat, Coleman, Inskip, and South Diversion Dams block or impede passage into approximately 55 miles of upstream habitat. The fish ladders at Eagle Canyon, Wildcat, and Coleman Diversion Dams are considered ineffective under most flow conditions and are impossible to maintain during high flows (California Department of Water Resources 1997, 1998). During average or wet water years, fish ladders at North Battle Creek Feeder, Eagle Canyon, Wildcat, Inskip, and Coleman Diversion Dams are generally ineffective for 3 to 8 months because flow exceeds the maximum effective capacity of the ladders by a factor of 10 or more. Fish ladders at Eagle Canyon and Coleman Diversion Dams were intentionally closed to fish passage under the 1998 Interim Flow Agreement (in anticipation of the Restoration project). This agreement provides sufficient flows below these dams to support salmonids, while blocking passage at the dams to prevent fish from entering the areas above the dams which have unstable flows and unscreened diversions.

Passage conditions that support migration of salmonids in Battle Creek also have been affected by the reduction in stream flow attributable to diversions for power production. Natural events, such as floods, can alter physical characteristics of the channel at natural passage impediments (falls, shoots and boulder jumbles), including depth of pools from which the fish jump, height that must be jumped, water velocity, slope of the streambed, and the length of the slope, all factors affecting passage. An on-site survey identified transitory barriers in 18 locations on North Fork Battle Creek and 5 locations on South Fork Battle Creek (Payne and Associates 1998). Passage of all or some adult Chinook salmon could be impaired under streamflow conditions in the range controlled by the hydroelectric diversions. On North Fork Battle Creek, obstacles require greater amounts of streamflow for unimpaired passage than on South Fork Battle Creek. In one extreme case on North Fork Battle Creek (RM 5.14), an especially steep transitory barrier was modified by CDFG in 1997 to provide numerous ascent routes at more gradual slopes (Kier Associates 1999).

b. *Reduced Instream Flows*

One of the primary impacts of the hydroelectric project affecting salmonid spawning success and survival in Battle Creek is streamflow. Diversion of flows for power generation has substantially reduced streamflow in nearly all the reaches of Battle Creek downstream of Keswick Diversion

Dam and South Diversion Dam. Minimum instream flow requirements under the current FERC license are 5 cfs in South Fork Battle Creek, and only 3 cfs in North Fork Battle Creek. Several of the tributaries to the creek (Soap, Ripley, and Baldwin Creeks) have minimum flow requirements of 0 cfs. These minimal streamflow requirements have greatly reduced holding, spawning and rearing habitat quality, and area available to salmonids, which has in turn caused a significant reduction in the population sizes and survival rates of these species.

c. *Increased Water Temperatures*

Habitat quality and salmonid survival in Battle Creek is significantly affected by water temperature as influenced by the hydro-project's diversion of cold spring water away from adjacent stream sections and reduced flows in the stream below diversion dams. Other factors that influence water temperature in Battle Creek include weather, channel form and dimension, shade, and natural flow levels. Flow diversion and subsequent warming substantially reduce the habitat area that can support migration, holding, spawning, and rearing of salmonids in Battle Creek (Kier Associates 1999).

Transbasin water diversions from North Fork Battle Creek to the South Fork tend to warm North Fork Battle Creek and cool South Fork Battle Creek. These operations have a detrimental effect on habitat conditions in the North Fork while potentially improving temperature conditions in the South Fork. However, the supply of cold water to the South Fork is not reliable. Canal and powerhouse outages occur at unpredictable times, producing substantial flow and temperature fluctuations that reduce habitat value for fish that are lured to the South Fork by the cold water releases from the hydropower system.

d. *Entrainment into Canals and Turbines*

Downstream migration of juvenile salmonids has also been impacted by the diversion of water at each dam (prior to the 1998 Interim Flow Agreement). Because up to 97 percent of the flow is diverted from Battle Creek for power production (Reclamation 2004) and fish screens are absent from all of these diversions, any juvenile fish spawned above the dams are likely to be entrained. Survival of passage through the power canals and turbines is thought to be minimal and most entrained fish are lost from the population. This reduction in juvenile survival is a key factor in the overall decline in salmonid populations in Battle Creek.

e. *Food*

Food availability and type affect fitness and survival of juvenile salmonids. Flow affects stream surface area and production of food. A primary factor affecting food production in Battle Creek is streamflow. Diversion for power generation has substantially reduced streamflow in all the reaches of Battle Creek downstream of Keswick Diversion Dam and South Diversion Dam. In addition, hydropower diversions entrain food organisms, exporting nutrients from segments of Battle Creek.

The density of adult salmon carcasses has been shown to increase nutrient input to stream systems and contribute to increased growth rates of juvenile salmonids (Wipfli *et al.* 2002). The historical reduction of Chinook salmon populations may have reduced food availability and productivity of Battle Creek.

2. Agricultural Effects

a. *Entrainment into Canals*

There are two significant agricultural diversions on lower Battle Creek, the Gover ditch and the Orwick ditch. Each diverts approximately 50 cfs from the creek. For many years, neither of these diversions had any sort of screening to prevent fish from being entrained into the ditches. Any juveniles that were entrained were most likely lost due to high water temperatures, predation, or desiccation in the fields. Within the last five years both diversions were fitted with fish screens. The screen on the Gover diversion meets most of the NMFS screening criteria and functions well in preventing entrainment of salmonids into the ditch during the irrigation season. However, during high flow periods, this screen is often overwhelmed by flows and debris. The screen panels are often removed during these periods allowing juvenile salmonids to be entrained into the ditch. Until recently, the screen on the Orwick diversion did not meet many of the NMFS screening criteria. It was often overtopped by high flows and screen panels were often removed completely allowing entrainment of juvenile salmonids. The bypass system on the Orwick screen also was inadequate; instead of returning screened fish back to the main channel of Battle Creek, it emptied into a side channel that was dry throughout much of the year. These impacts have caused increased stress and mortality of listed salmonids that were entrained into the diversion.

The fish screening facilities on the Orwick diversion have recently been retrofitted to meet the NMFS fish screening criteria. Two separate actions occurred to improve the effectiveness of the screen and improve survival of juvenile salmonids that enter the Orwick diversion. In 2006, a

600 foot bypass pipe was installed to return fish back to the main channel of Battle Creek, and in 2007 a headgate water control structure was installed. The headgate prevents the screen from being overtopped by high flows. The new bypass pipe replaces an inadequate pipe so that at all times during the year, juvenile salmon and steelhead are safely maintained in a wetted environment from the time that they are diverted from the mainstem Battle Creek until the time that they are returned to Battle Creek via the bypass pipe (Tricia Parker, USFWS, personal communication).

b. *Reduced Instream Flows*

These diversions can also divert a significant proportion of the total stream flow in Battle Creek during low water periods. This reduction in stream flow can lead to increased water temperatures and reduced food production and availability, resulting in reduced fitness and survival of juvenile and adult salmonids.

c. *Seasonal Dams*

Irrigators on both ditches have periodically pushed up large gravel dams to ensure sufficient water is diverted into their ditches. These dams are built using heavy equipment within the stream bed to dig up the bed of the creek and pile it into large berms that back water up in front of the diversions and deflect the water into the ditches. This instream construction and disruption of the stream bed can cause direct injury and mortality of juvenile salmonids and incubating eggs. These activities also can cause increased mobilization of fine sediments which can negatively impact downstream salmonids and spawning beds (see Effects of the Action section).

3. <u>Hatchery Effects</u>

a. *Migration Impacts at Hatchery Weir*

CNFH operates a barrier weir along with a fish ladder 5.5 miles upstream of Battle Creek's confluence with the Sacramento River (FWS 2001). The upstream fish ladder is well designed and relatively effective in allowing unimpeded passage when it is opened. When the fish ladder is closed (August 1 through early March), the barrier weir either blocks passage or diverts fish into the hatchery. The barrier weir is operated to provide broodstock for the hatchery and to manage and monitor passage of adult salmonids into upper Battle Creek. The current management objectives are to:

- divert adult fish into the hatchery facilities to provide broodstock for hatchery production;
- minimize the potential for hybridization between co-occurring runs of Chinook salmon in Battle Creek upstream of the barrier weir;
- minimize interactions between natural and hatchery runs of Chinook salmon and steelhead in Battle Creek upstream of the barrier weir;
- minimize the risk of infectious hematopoietic necrosis virus being shed into CNFH water supply upstream of the barrier weir; and

- monitor and study passing salmonids.

Because the upstream ladders on the barrier weir are closed from August 1 through early March, winter-run Chinook salmon and steelhead, which migrate upstream during this period, are likely to be impacted through migration delay, blockage, capture, handling, and unintentional mortality within the hatchery facilities (FWS 2000). Spring-run Chinook salmon migrate into Battle Creek from March through July and therefore are unlikely to be significantly impacted by the operation of the barrier weir (NMFS 2005).

b. *Entrainment Into Water Intakes*

Diversion of the water supply for CNFH out of Battle Creek results in the entrainment of juvenile salmonids into the hatchery intake system. The primary diversion point for CNFH (intake 1) is located in the tailrace of the Coleman Powerhouse. The water discharged from this powerhouse (and collected by intake 1) is diverted from the creek far upstream, above the natural passage barriers, and therefore is free of anadromous salmonids (FWS 2000). CNFH also uses two other water intakes on Battle Creek (intakes 2 and 3). These intakes entrain or impinge juvenile salmonids because they take water directly from lower Battle Creek and they have, until recently, been unscreened (intake 3 was recently fitted with a screen which does not meet all of NMFS' screening criteria, intake 2 remains completely unscreened). The estimated annual levels of impingement and/or entrainment of listed salmonids at these 2 intakes are 814 spring-run Chinook salmon, and 6,269 steelhead (FWS 2000).

Periodic salvage operations conducted by FWS hatchery personnel have been moderately successful at rescuing entrained fish from the hatchery canal and sand filter. An example of one such operation took place from May 24 to July 13, 2000, during which 782 Chinook salmon and 749 steelhead were collected and released back into Battle Creek.

c. *Deleterious Genetic Effects*

Genetic integration of CNFH domestic stocks with wild Battle Creek salmonid populations has occurred over many years. During the winter-run propagation program at CNFH there was evidence of hatchery crossings of winter-run Chinook salmon with wild Battle Creek spring-run Chinook salmon (FWS 2000). The steelhead propagation program at CNFH also has had a long history of crossing hatchery origin fish with naturally-spawned Battle Creek fish and passing hatchery origin adults into upper Battle Creek to spawn with wild steelhead. Because of domestication effects in hatchery stocks (*i.e.*, a reduction in fitness of a stock due to prolonged hatchery propagation), the integration of these domestic stocks with wild populations, particularly wild populations whose numbers have been depressed through other factors, can reduce the overall fitness of the wild population and reduce its likelihood of recovering to self-sustaining levels (Chilcote 2003; Reisenbichler *et al.* 2003).

A recent decision by the agencies involved in management of steelhead and CNFH operations (FWS, NMFS, CDFG, and Reclamation) has ended the practice of deliberately passing hatchery origin steelhead above the CNFH barrier weir. The cessation of passing hatchery steelhead above the weir was implemented in order to allow the naturally-spawning population in upper Battle Creek to recover without excessive influence from hatchery stocks.

4. Predation

Predation by native and nonnative species may cause substantial mortality of salmonids and other species, especially where the stream channel or habitat conditions have been altered from natural conditions (California Department of Water Resources 1995). The existing diversion dams in the action area may create environmental conditions that increase the probability that predator species will capture juvenile Chinook salmon and steelhead during downstream movement. Water turbulence in the vicinity of the dams and other structures may disorient migrating juvenile Chinook salmon and steelhead, increasing their vulnerability to predators. In addition, changes in water temperature, flow velocity and depth affect the quality of habitat and potentially increase vulnerability of fish species to predation by other fish species, birds, and mammals.

C. Likelihood of Species Survival and Recovery in the Action Area

Under baseline conditions, without implementation of the Restoration project, the likelihood of survival and recovery of naturally-reproducing winter-run Chinook salmon, spring-run Chinook salmon, and steelhead in Battle Creek is very low. Winter-run Chinook salmon are thought to be completely extirpated from the creek, and continuation of the current hydropower operations would be likely to continue to produce the poor habitat conditions in Battle Creek under which winter-run Chinook salmon have been unable to survive. Naturally-reproducing spring-run Chinook salmon and steelhead still maintain remnant populations in Battle Creek, but their numbers have shown a decreasing trend in recent decades. Without access to the upper reaches of the creek, screening of the hydropower diversions, and increased minimum flow requirements, it is unlikely that they would be able to maintain these remnant populations, and even less likely that they would actually recover to a point of long-term sustainability.

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. 1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat as defined in 50 CFR 402.02. Instead, this biological opinion relies upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This biological opinion assesses the effects of the proposed Battle Creek Hydroelectric Project (FERC 1121) on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, and their designated critical habitats.

In the section II, "Description of the Proposed Action," of this biological opinion, NMFS provided an overview of the action. In the sections III and IV, "Status of the Species and Critical

Habitat" and "Environmental Baseline," respectively, NMFS provided an overview of the threatened and endangered species and critical habitat in the action area of this consultation.

Regulations that implement section 7(a)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. 1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. 1536).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of the proposed action on individual members of the listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering spawning substrate, altering ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or noise disturbance). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable exposure to those effects (the extent of temporal and spatial overlap between individuals of the species and the effects of the action). Once we have identified the exposure of the species to the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

The final step in conducting the "jeopardy" analysis is to consider the additive effects of the environmental baseline, the effects of the action and any reasonably foreseeable cumulative effects to determine the potential for the action to affect the survival and recovery of the species, or the conservation value of their designated critical habitat.

To evaluate the effects of the proposed action, NMFS examined the FERC license amendment application and Biological Assessment for continued Hydroelectric operations after Phase 1A of the Restoration Project, to identify likely impacts to listed anadromous salmonids within the action area, based on the best available information.

The primary information used in this assessment include fishery information previously described in the "Status of the Species and Critical Habitat" and "Environmental Baseline" sections of this biological opinion; studies and accounts of the impacts of water diversions, dams, and artificial flow fluctuations on anadromous species; and documents prepared in support of the proposed action.

B. Assessment

The assessment will consider the nature, duration, and extent of the effects of the proposed action relative to the migration timing, behavior, and habitat requirements of Federally listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, and the magnitude timing, frequency, and duration of project impacts to these listed species. Specifically, the assessment will consider the potential impacts related to adverse effects to these species and their habitat resulting from the continued operation of the Hydroelectric Project following dam removal, ladder improvements, and new flow requirements. The project includes conservation measures, an Adaptive Management Plan and a Facility Monitoring Plan to minimize potential impacts.

The amendment to the Hydroelectric Project license (the proposed action) is necessary for the implementation of the Restoration Project. In general, the continued operation of the Hydroelectric Project, following implementation of phase 1A of the Restoration Project is expected to result in overall net benefits to migration, flow, temperature, entrainment, food availability and predation, while continuing to cause some adverse effects to listed species in the Battle Creek watershed.

1. Hydroelectric Project Effects

a. Migration Impacts at Dams

Migration habitat includes the specific pathways that support the movement of adult Chinook salmon and steelhead between ocean and freshwater habitats. Delay and multiple attempts at passing the dams or natural barriers may reduce the survival of adults because of injury and exhaustion. Following delays or failed attempts at passing dams or natural barriers, adults may remain downstream of the barriers, where survival to spawning may be reduced, as well as survival of eggs, which may be reduced by warmer water temperature (Jones & Stokes 2005).

Phase 1A of the Restoration Project will include removal of Wildcat Diversion Dam, and screening and ladder construction for Eagle Canyon Diversion Dam and North Battle Creek Feeder Diversion Dam, on North Fork Battle Creek. This will essentially open up access to approximately 9 miles of upstream passage.

While the new ladders and screens will incorporate state of the art designs and features to meet or exceed all current regulatory standards and to maximize the potential for successful fish passage past these dams, there is always some level uncertainty as to the actual efficacy of these types of facilities once they are constructed and operating under real world conditions. The AMP for Fish Passage lays out a comprehensive plan to address these uncertainties and remedy any problems by monitoring and analyzing the actual performance of these facilities through analysis of the physical conditions in and around the structures and through radio telemetry of the fish passing (or attempting to pass) these ladders and screens (Figure 2).

On South Fork Battle Creek, upstream migration will continue to be blocked at Coleman Diversion Dam. Coleman Diversion and South Diversion Dams will still be in place after Phase 1A of the Restoration Project, as well as Lower Ripley Diversion Dam and Soap Creek Feeder

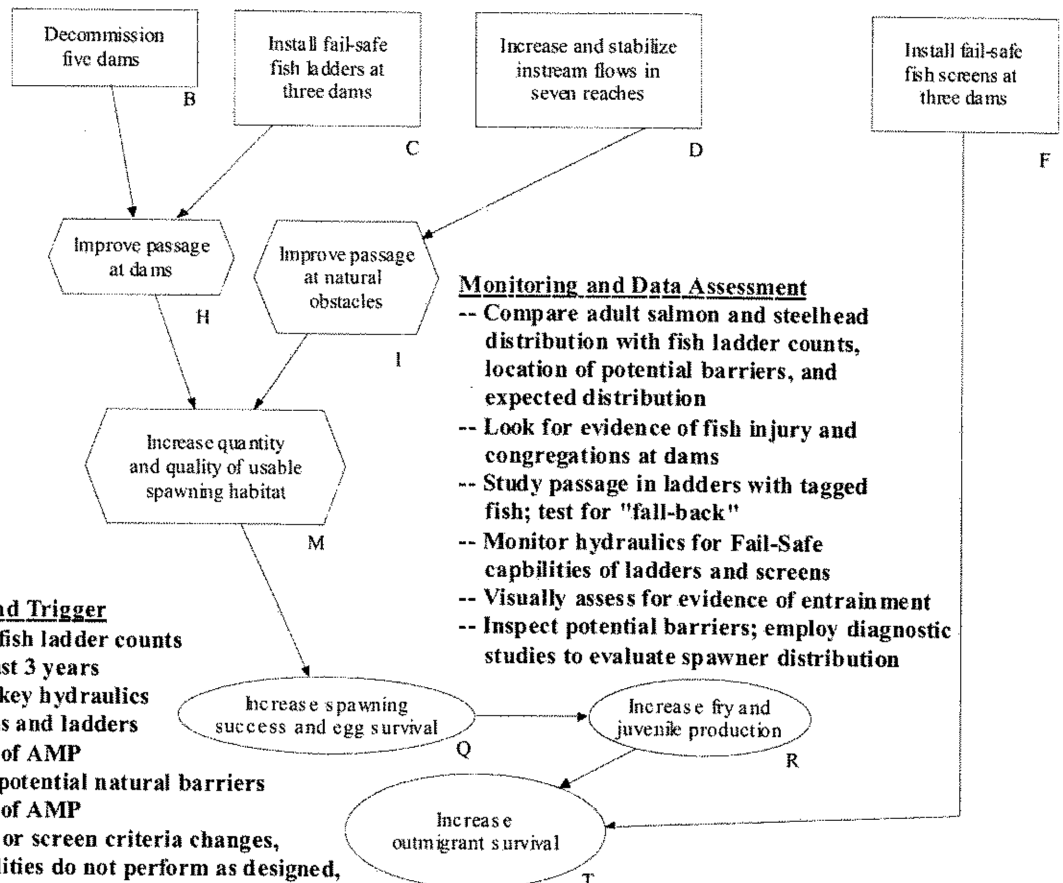
Diversion Dam (tributaries to South Fork Battle Creek). Therefore, approximately 16 miles of historic habitat on South Fork Battle Creek will continue to be blocked to upstream migration. In addition, all habitat in the tributaries will continue to be blocked as they are above Coleman Diversion Dam. It is not known how much habitat for spring-run and winter-run Chinook salmon Lower Ripley Creek and Soap Creek would provide, but current analysis indicate that after Phase 2 of the Restoration Project opens up access to these tributaries, they will at least provide a few miles of suitable habitat to steelhead.

Fish Passage Adaptive Management Model

Factors Affecting Fish Passage
- -- The presense of dams in anadromous habitat impedes sate upstream and downstream passage
- -- Inadequate or inoperative fish ladders impede passage at dams
- -- The lack of operable fish screens poses significant entrainment risk especially to juvenile fish
- -- Natural obstacles may impede upstream fish passage at low instream flows

Species/Life Stages Affected
- -- Adult and juvenile salmon and steelhead; varies by factor

Key Uncertainties
- ? Model predictions for natural barriers
- ? Field studies of natural barriers are old
- ? Will fish ladders provide adequate passage



Monitoring and Data Assessment
- -- Compare adult salmon and steelhead distribution with fish ladder counts, location of potential barriers, and expected distribution
- -- Look for evidence of fish injury and congregations at dams
- -- Study passage in ladders with tagged fish; test for "fall-back"
- -- Monitor hydraulics for Fail-Safe capbilities of ladders and screens
- -- Visually assess for evidence of entrainment
- -- Inspect potential barriers; employ diagnostic studies to evaluate spawner distribution

Timeline and Trigger
- – Monitor fish ladder counts for at least 3 years
- – Monitor key hydraulics at screens and ladders for term of AMP
- – Monitor potential natural barriers for term of AMP
- – If ladder or screen criteria changes, or if facilities do not perform as designed, or if injury or entrainment is evident, or if spawner distribution is abnormal for 3 years or if adult salmon/steelhead migration is impeded by natural obstacle, then implement responses.

Response
- -- Varies according to trigger but includes diagnostic studies and potential modification of ladders or screens
- – Natural barriers may be physically modified or rectified with flow releases

Figure 2. Fish Passage Adaptive Management Model.

b. Decrease in Homing Success - False Attraction

The mechanisms that allow salmonids to return to their natal stream generally stem from their ability to recognize the olfactory characteristics of their home stream (Hasler and Scholz 1983). Juvenile salmonids remember, or "imprint on," the smell of organic compounds that are uniquely characteristic of a given stream or stream reach. When returning to fresh water to spawn, adult salmonids use these olfactory cues to locate and return to the stream reach where they were hatched and reared. Homing may be influenced by such factors as flow, water temperature, presence of other salmon, and habitat quality (Pascual and Quinn 1994; Quinn 1984, 1997). For instance, the homing precision of salmon increases with the relative magnitude of streamflow present in the home stream (Hindar 1992).

Following implementation of Phase 1A, normal operation of South Powerhouse will result in a continual discharge of mixed North and South Fork water to South Fork Battle Creek below Coleman Diversion Dam. Mixing of North Fork Battle Creek flow with South Fork Battle Creek flow potentially results in false attraction of adult Chinook salmon and steelhead to non-natal reaches of Battle Creek. Although the frequency and relative magnitude of powerhouse water discharge into the natural stream channel will decrease after all phases of the Restoration Project, this decrease will not occur after Phase 1A only. The key uncertainty in adaptively managing false attraction is whether the facility modifications and implementation measures will be sufficient to avoid false attraction. This will be monitored and analyzed as shown in Figure 3.

False attraction of winter-run Chinook salmon to the South Fork may have been indicated by previous observations of winter-run Chinook salmon spawning below Coleman Diversion Dam (CDFG 1996). Winter-run Chinook salmon eggs spawned in this reach of the South Fork are unlikely to survive the warm summer water temperatures that occur in this reach. In general, water temperatures are warmer in South Fork Battle Creek, and spawning and rearing habitat is of lower quality for Chinook salmon and steelhead than it is in North Fork Battle Creek, especially during extremely dry years (Pacific Gas & Electric Company 2001). The false attraction of North Fork fish to the South Fork could result in lower overall production for the Battle Creek watershed (Jones & Stokes 2004). Operation and maintenance activities that could introduce North Fork water into the South Fork are discussed further below.

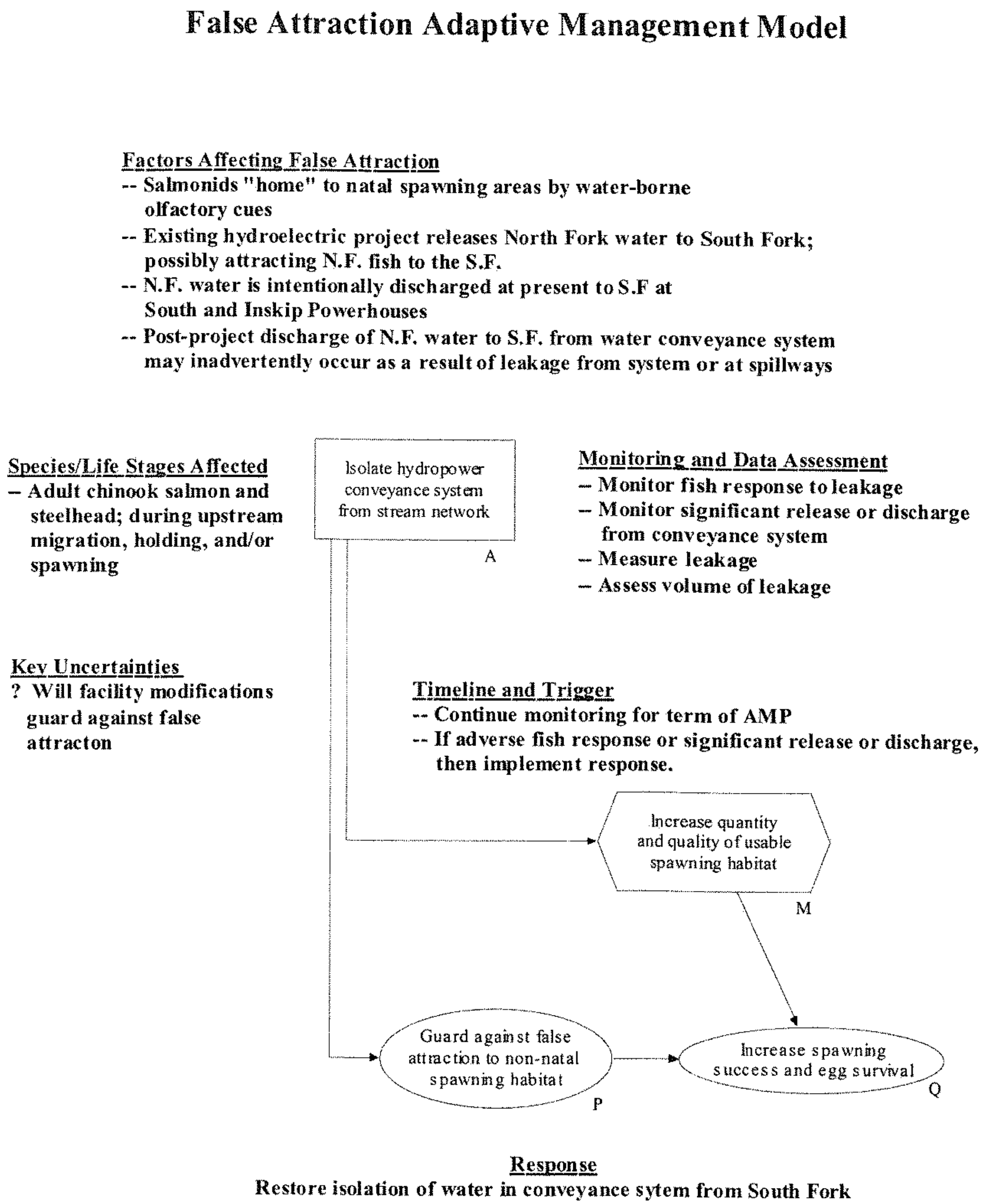


Figure 3. False Attraction Adaptive Management Model.

Abnormal conditions that would inject sudden increases of water into South Fork, North Fork, or the mainstem after Phases 1A include:

- Inskip Canal overtopping because of unexpected and extremely heavy rainfall resulting in a historic runoff event released at any or all of the five canal spillways. This event has a low probability of occurrence, with a frequency of once every 3 years. The volume of the spill, which would consist of mixed water, could be as much as 125 cfs to the South Fork, and the spill could last up to 12 hours.

- Inskip Canal overtopping because of an unexpected blockage of the canal from a storm-related landslide. This type of event has not occurred at this project site, but theoretically is possible. The volume of the spill, which would consist of mixed water, could be as much as 220 cfs to the South Fork and would last until the blockage was cleared.

- Coleman Canal overcharging released at spillway adjacent to siphon #1. This condition can be caused by an unexpected and extremely heavy rainfall period resulting in a historic runoff event. This event has a low probability of occurrence, with a frequency of once every 3 years. The spill of 75 cfs of mixed water to the South Fork could last up to 12 hours.

- South Powerhouse startups that combine spillway flows with powerhouse flows and temporarily cause spills of mixed water in South Fork Battle Creek. This event, which could occur as a result of equipment failure, has a low probability of occurrence, with a frequency of once per year. The volume of the release could be as much as 150 cfs. The duration of such an event would be brief, lasting approximately 15 minutes.

- Spilled water from Inskip Canal at the sand trap downstream of existing Inskip Tunnel #1. Maintaining the sand trap and release valve free of debris is necessary to protect the canal and hillside from potential overtopping events related to unexpected canal blockages. This event has a low probability of occurrence, with a frequency of twice per year. The spill of 50 cfs to South Fork Battle Creek could last up to 4 hours per event.

- Inskip Powerhouse startups that combine spillway flows with powerhouse flows and temporarily increase flows in South Fork Battle Creek below Coleman Diversion Dam. This event, which could occur as a result of equipment failure, has a low probability of occurrence, with a frequency of once per year. The duration of the spill of 270 cfs of mixed water into South Fork Battle Creek would be brief, lasting approximately 15 minutes.

- Spilled water from Coleman Canal at Siphon # 1 into South Fork Battle Creek. This event would occur twice per year when the canal grid is cleaned. The spill of an estimated 220 cfs of mixed water could last up to 4 hours.

- Coleman Powerhouse startups that combine spillway flows with powerhouse flows and temporarily increase flows in mainstem Battle Creek. This event, which could occur as a result of equipment failure, has a low probability of occurrence, with a frequency of once per year. The duration of the release of 340 cfs would be brief, lasting approximately 15 minutes.

- Increased instream flow releases from North Battle Creek Feeder and Eagle Canyon Diversion for the purpose of moving gravels from behind diversions. Flows of up to 120 cfs can be released for a period of weeks at a time. However, this action occurs only during periods of high creek flow and existing high background turbidity.
- Increased instream flow releases from South, Inskip, and Coleman Diversion Dams to transport gravels trapped behind the diversion dams. Flows of up to 500 cfs can be released for a period of weeks at a time. However, this action occurs only during periods of high creek flow and existing high background turbidity.
- Volta, Volta 2, South, Inskip, and Coleman Powerhouse shutdowns that result in spilled water at forebays. Under most normal shutdowns, water is bypassed and discharged into the tailrace area, similar to when the unit is on line. Under certain situations, water cannot be discharged into the tailrace and therefore is spilled at the forebays. This can result in a discharge of mixed water at South and Inskip Powerhouses with temporary increases in turbidity. This type of event can occur approximately twice per year per powerhouse, lasting an average of 4 hours per occurrence (PG&E 2008).

c. *Planned and Unplanned Flow Fluctuations – Temperature Fluctuations and Juvenile Stranding*

On South Fork Battle Creek, flow fluctuations occur in the Coleman reach when scheduled maintenance at Coleman Powerhouse and Canal results in spills at the Coleman Diversion Dam. These spills continue to occur until canal maintenance is completed. When the canal is brought back into service, it is common for the Coleman Powerhouse to remain offline, thereby shifting the spills at Coleman Diversion Dam downstream to the mainstem reach adjacent to Coleman Forebay until the powerhouse is brought back online.

Outages that would result in the spill of canal water to South Fork Battle Creek below Inskip Dam or the mainstem include:

- Inskip Canal outages. The planned outages typically will occur on an annual basis and last 4 days, with the probability of a 10-day outage occurring once every 5 years. When these outages occur, the volume of the discharge could reach the maximum Inskip Diversion capacity, which is 220 cfs. Unexpected outages of Inskip Canal also may occur, although these would be rare. These outages are estimated to occur once every 5 years, with an average duration of 3 days. These planned and unplanned outages of the Inskip Canal also are expected to occur under Phase 2.
- Coleman Canal outages upstream of Siphon #1. These outages typically will occur annually and last 4 days, with the probability of a 10-day outage occurring once every 5 years. When these outages occur, the volume of the discharge will equal the discharge from Inskip Powerhouse, which is a maximum of 270 cfs. Unexpected outages of Coleman Canal also may occur, although these would be rare. These outages are estimated to occur once every 5 years, with an average duration of 3 days. These planned and unplanned outages of the Coleman Canal are also expected to occur under Phase 2.
- Coleman Powerhouse maintenance outages. Coleman Powerhouse maintenance outages will be combined with Coleman Canal outages and are expected to occur once per year

and last for 4 days. During these planned outages, the Coleman Forebay will be left "watered up." Spill (up to 270 cfs) at Coleman Diversion Dam will occur initially in order to dewater the canal for maintenance. Once maintenance is completed, the Coleman Canal will be watered up and spill (up to 340 cfs) then will resume at the Coleman Forebay spillway until the powerhouse is brought back on line. Outages will occur between June and the end of August as requested by CNFH. Following these outages, the powerhouse will be brought back on line using the 0.1 foot/hour criterion to protect aquatic resources in the reach of Battle Creek located between the forebay spill channel and the powerhouse tailrace.

- Unplanned Coleman Powerhouse or Forebay outages. On average, outages of this nature will last up to 2 hours and occur four times per year. These outages are a result of storm-related conditions or equipment malfunction or failure. When water cannot be passed through the powerhouse, water will be spilled at the Coleman Forebay. These outages are expected to last for minutes or, in unusual situations, for months in the event of a catastrophic failure. Following these outages, the powerhouse will be brought back on line using the 0.1 foot/hour criteria to protect aquatic resources in the reach of Battle Creek located between the forebay spill channel and the powerhouse tailrace. This condition potentially may cause minimum flows to drop below the current minimum flow requirement of 150 cfs measured at the USGS gage above CNFH, particularly in the lower-flow months, until the spill from Coleman Forebay reaches the gage. This may take up to 2 hours.

All of the planned annual outages discussed above will occur during spring of the year (unless recommended otherwise by the resource agencies), when flows in South Fork Battle Creek are typically at their highest. In addition, the 0.1 ft/hr ramping rate criteria will be applied when the canals are re-watered following completion of these planned outages.

Outages that would result in spills to North Fork Battle Creek below North Battle Creek Feeder and Eagle Canyon Dams include:

- Lower Cross Country Canal outages. These outages typically will occur every year and last 4 days, with a 10-day outage occurring once every 5 years. Flow would equal the diversion of North Battle Creek Feeder, which has a maximum of 55 cfs.

- Eagle Canyon Canal outages. These outages typically would occur every year and last 4 days, with a 10-day outage occurring once every 5 years. Flow would equal the diversion of Eagle Canyon Canal, which has a maximum of 65 cfs (PG&E 2008).

In addition, unexpected outages on the North Fork caused by storm-related landslides, debris, or vandalism also could lead to sudden flow fluctuations in the South Fork or North Fork Battle Creek. It is anticipated that these conditions would be extremely rare, occurring once every 10 years on average. If such an event were to occur, the amount of water discharged into Battle Creek would vary according to the volume of water being diverted at the time of the incident, with the maximum volume of the spill equal to the capacity of the affected canal. In addition, the duration of these spills could range from a few hours to 1 month, and the spills would be discharged into Battle Creek at the point of diversion for the affected canal (PG&E 2008).

Separation of the powerhouse discharge from the natural stream channel of South Fork Battle Creek, as is planned in future phases of the Restoration Plan, would reduce the frequency of flow fluctuations and is likely to benefit steelhead and Chinook salmon. However, under the proposed action (Phase 1A), continued variation in flows attributable to powerhouse outages will have adverse effects on steelhead and winter- and spring- run Chinook salmon. Adverse effects may include increased discharge of North Fork water into the South Fork, fluctuations in water temperature and rapid fluctuations in stream flows resulting in stranding of fish. However, ramping rates and other measures as outlined in the Adaptive Management Plan (discussed below) will be implemented to minimize the potential for stranding (PG&E 2008).

d. *Measures to reduce dewatering to juvenile salmonids (e.g. stranding)*

High flows occurring as a result of planned and unplanned outages gradually will be reduced as the power plants and canals come back on line (Chapter 3, "Project Description," of the final EIS/EIR [Jones & Stokes 2005]). In addition, the Restoration Project and its Adaptive Management Plan specify that planned outages will occur during the wet season (February 1 through April 30 or as otherwise specified by the resource agencies) when spill conditions will maintain full channel flows after the outage, making the need for ramping operations less likely. Planned outages occurring during the wet season also will reduce the potential for false attraction because the proportion of flow composed of mixed water will be reduced.

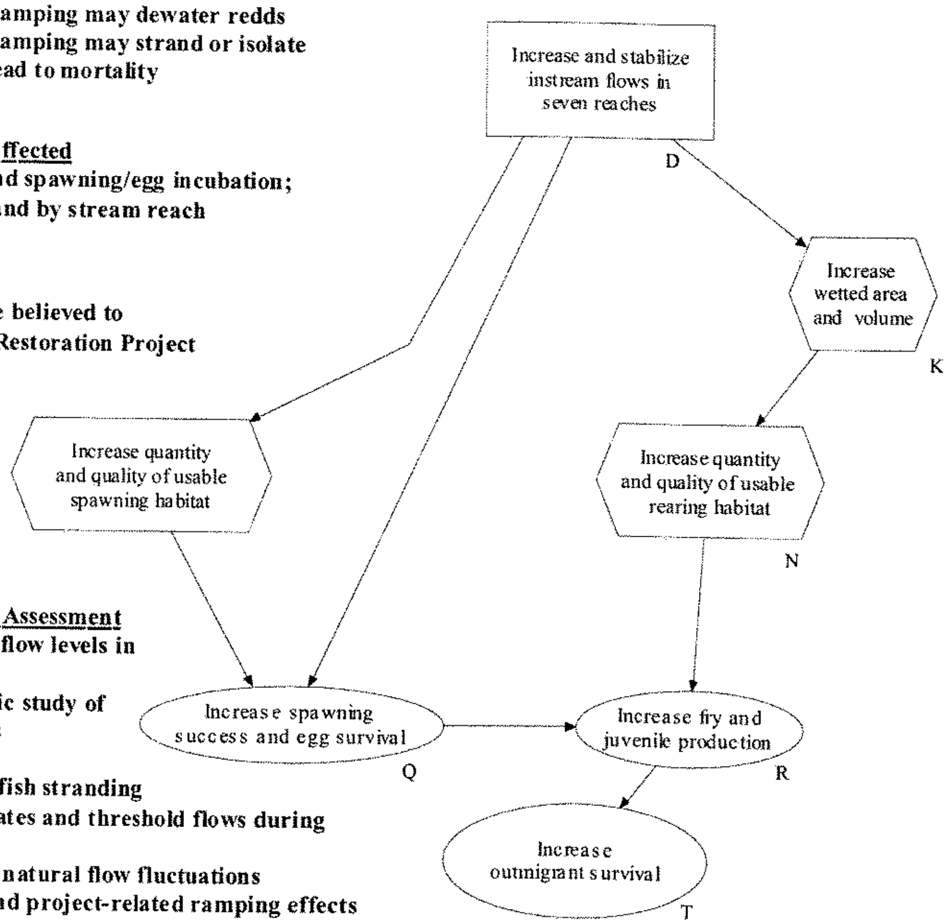
Ramping rates of 0.1 foot/hour will be implemented and monitored during scheduled outages, although all available information suggests that the low uncertainty and risk associated with post-project ramping does not warrant the design of specific studies for this monitoring task prior to the Restoration Project implementation. Evidence of fish stranding will be monitored throughout the term of the Adaptive Management Plan and, depending on the particular trigger and outcome of diagnostic studies, more appropriate ramping rates or threshold flows may be recommended as an adaptive management response. Currently, a 460-cfs threshold for ramping has been established for South Fork Battle Creek, and future studies conducted under the Adaptive Management Plan potentially will identify a threshold for North Fork Battle Creek and mainstem Battle Creek near Coleman Powerhouse. The Adaptive Management Plan provides more detail, including a ramping rate model (Figure 4; Terraqua, Inc. 2004). If direct evidence of an adverse fish response to leakages or discharges from the Hydroelectric Project is observed, or if facilities monitoring identifies significant discharges from the water conveyance system, actions will be taken to restore the isolation of water in the conveyance system from the South Fork Battle Creek as prescribed in the Adaptive Management Plan (Terraqua, Inc. 2004).

Ramping Rate Adaptive Management Model

Factors Affecting Fish Stranding/Isolation
- Flow fluctuations/ramping may dewater redds
- Flow fluctuations/ramping may strand or isolate juvenile fish and lead to mortality

Species/Life Stages Affected
- Juvenile rearing and spawning/egg incubation; varies by month and by stream reach

Key Uncertainties
? no uncertainties are believed to threaten success of Restoration Project



Monitoring and Data Assessment
- Evaluate threshold flow levels in South Fork
- Conduct a diagnostic study of ramping thresholds in North Fork
- Collect evidence of fish stranding
- Monitor ramping rates and threshold flows during scheduled outages
- Potentially monitor natural flow fluctuations
- Compare natural and project-related ramping effects

Timeline
- North Fork diagnostic study will be completedas soon as possible, possibly in spring 2004.
- Fish stranding will be monitored for term of AMP
- Other monitoring to be conducted when applicable

Trigger and Response
-- If project-induced, biologically significant stranding or isolation is observed, then evaluate natural stranding and isolation, conduct a diagnostic assessment of ramping effects using statistically valid techniques, compare project-induced ramping with natural flow fluctuations and recommend a more appropriate Ramping Rate.

Figure 4. Ramping Rate Adaptive Management Model.

e. *Minimum Instream Flow*

One of the primary impacts of the Hydroelectric Project affecting salmonid spawning success and survival in Battle Creek is streamflow. Diversion of flows for power generation has reduced streamflow substantially in nearly all the reaches of Battle Creek downstream of Keswick Diversion Dam and South Diversion Dam. Minimum instream flow requirements under the current FERC license are 5 cfs in South Fork Battle Creek, and only 3 cfs in North Fork Battle Creek. Several of the tributaries to the creek (Soap, Ripley, and Baldwin Creeks) have minimum flow requirements of 0 cfs. These minimal streamflow requirements have greatly reduced holding, spawning, and rearing habitat quality and area available to salmonids, which has in turn caused a significant reduction in the population sizes and survival rates of these species (NMFS 2005).

These diversions also can divert a significant proportion of the total streamflow in Battle Creek during low-water periods. This reduction in streamflow can lead to increased water temperatures and reduced food production and availability, resulting in reduced fitness and survival of juvenile and adult salmonids (NMFS 2005).

The Restoration Project (Phase 1A) will increase the minimum instream flow requirements in North Fork Battle Creek. These increases in minimum instream flows will result in an increase in the total area of spawning and rearing habitat for steelhead, spring-run Chinook salmon, winter-run Chinook salmon, and fall-/late fall–run Chinook salmon in Battle Creek (Tables 8 and 9). Relative to existing (baseline) conditions, the total area of spawning and rearing habitat for these species will increase following implementation of Phase 1A of the Restoration Project. The increased spawning and rearing habitat area associated with these increased minimum flows is expected to increase the abundance of steelhead and spring-, winter-, and fall-/late fall–run Chinook salmon in Battle Creek (Jones & Stokes 2004).

Under Phases 1A, increases in total spawning and rearing habitat area will occur largely as a result of implementing proposed actions on North Fork Battle Creek, although some additional habitat gains over baseline conditions also will occur in South Fork Battle Creek below Coleman Diversion Dam and in mainstem Battle Creek (Tables 8 and 9) by maintaining the 2006 Interim Flow Agreement until Phase 2 is implemented. For example, although access to the South and Inskip reaches of the South Fork will remain blocked following implementation of Phases 1A, the Interim Flow Agreement (which will continue until Phase 2 of the RP is complete) insures minimum flows of 30 cfs, which will continue to provide increases in spawning and rearing habitat in the Coleman (SF) and mainstem reaches over baseline or implementation of Phase 1A alone.

Overall, under Phases 1A, increases in total spawning habitat area for steelhead will exceed those for winter-, spring-, and late fall–run Chinook salmon, although total area of spawning habitat for spring- and winter-run Chinook salmon will exceed total area of spawning habitat for steelhead and late fall–run Chinook salmon. Increases in total rearing habitat area for winter-, spring-, and late fall–run Chinook salmon will be noticeably greater than increases in habitat area for steelhead (Tables 8 and 9).

If Observed fish habitat use does not match expectations, verification studies will be conducted, new habitat suitability criteria may be developed, and changes to instream flows may be recommended. Habitat quantity, fish use of habitat, and advancements of science or modeling of instream flows will be monitored and analyzed as summarized in Figure 5)

Table 8. Calculated Spawning Area (Acres) for Peak Months of Steelhead and Chinook Salmon Lifestage Occurrence for Minimum Flow Requirements (Baseline vs. Phase 1A)

Reach of Battle Creek	Steelhead Spawning Area [a]	Spring-Run Chinook Spawning Area [b]	Winter-Run Chinook Spawning Area [c]	Late Fall-Run Chinook Spawning Area [d]
Baseline				
Keswick	0.06	–	–	–
North Battle Creek Feeder	0.01	0.04	0.04	0.04
Eagle Canyon	0.01	0.07	0.07	0.07
Wildcat	–	0.05	0.05	0.05
South	0.12	0.39	0.39	0.39
Inskip	–	0.2	0.2	0.2
Coleman	–	0.17	0.17	0.17
Main	0.27	0.55	0.55	0.55
Total	**0.47**	**1.47**	**1.47**	**1.47**
Restoration Project—Phase 1A				
Keswick	0.06	–	–	–
NBC Feeder	0.89	0.69	0.69	0.63
Eagle Canyon	0.57	0.44	0.44	0.39
Wildcat	0.34	0.28	0.28	0.25
South	–	–	–	–
Inskip	–	–	–	–
Coleman[e]	0.4	0.9	0.9	0.9
Main[e]	1.5	2.2	2.2	1.5
Total	**3.76**	**4.51**	**4.51**	**3.67**

Note:

If the removal of a dam under an alternative precludes the need for a minimum flow ement, the minimum flow requirement for the adjacent upstream or downstream dam is applied.

a Values are for the month of February.

b Values are for the month of September.

c Values are for the month of June.

d Values are for the month of March.

e Values are from Appendix H (Tables H1 and H6) of final EIS/EIR.

Table 9. Calculated Rearing Area (Acres) for Peak Months of Steelhead and Chinook Salmon Lifestage Occurrence for Minimum Flow Requirements (Baseline vs. Phase 1A)

Reach of Battle Creek	Steelhead Rearing Area [a]	Spring-Run Chinook Rearing Area [b]	Winter-Run Chinook Rearing Area [c]	Late Fall-Run Chinook Rearing Area [d]
Baseline				
Keswick	1.92	–	–	–
North Battle Creek Feeder	1.62	0.62	0.62	0.62
Eagle Canyon	1.02	0.41	0.41	0.41
Wildcat	0.9	0.36	0.36	0.36
South	4.26	2.17	2.17	2.17
Inskip	2.3	0.53	0.53	0.53
Coleman	0.11	0.37	0.37	0.37
Main	13.18	4.39	4.39	4.39
Total	**25.31**	**8.85**	**8.85**	**8.85**
Restoration Project—Phase 1A				
Keswick	1.92	–	–	–
NBC Feeder	6.06	4.14	4.68	4.68
Eagle Canyon	2.93	2.42	2.42	2.42
Wildcat	2.62	2.23	2.23	2.23
South	–	–	–	–
Inskip	–	–	–	–
Coleman[e]	3.40	2.40	2.40	2.403
Main[e]	13.10	17.0	17.1	17.1
Total	**30.03**	**28.19**	**28.83**	**28.83**

Note: If the removal of a dam under an alternative precludes the need for a minimum flow requirement, the minimum flow requirement for the adjacent upstream or downstream dam is applied.

a Values are for the month of July.

b Values are for the month of February.

c Values are for the month of October.

d Values are for the month of July.

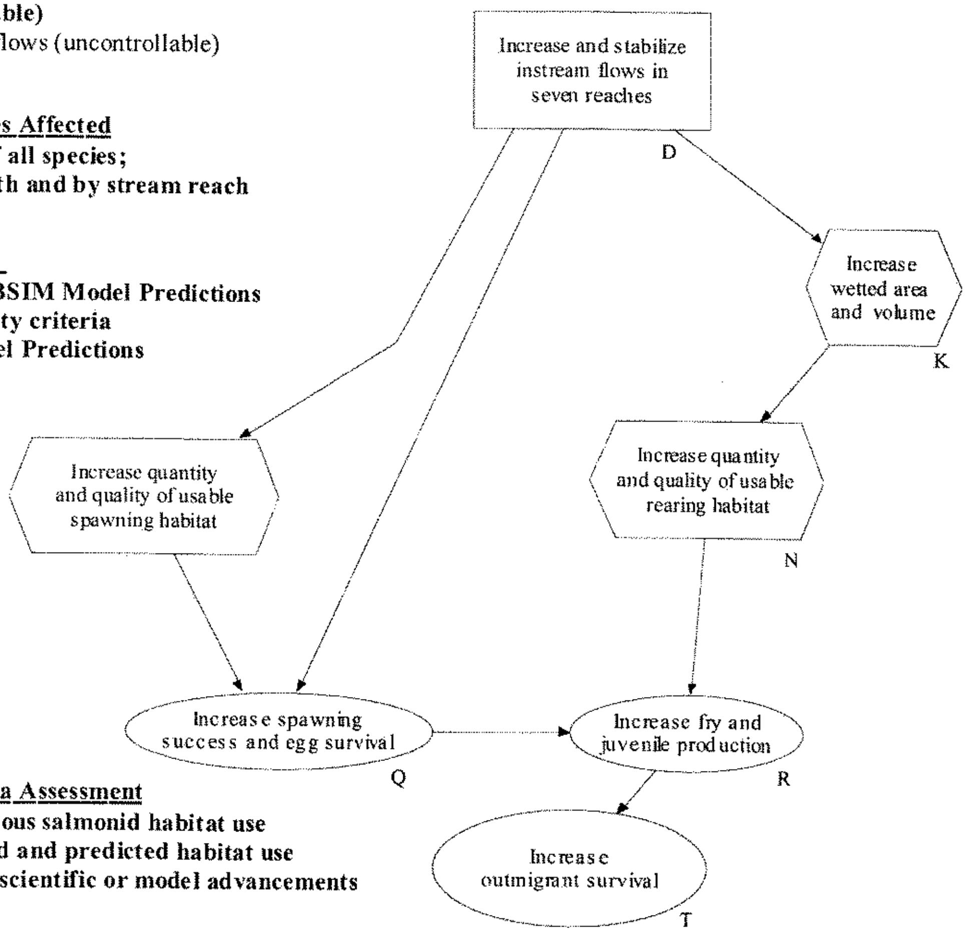
e Values are from Appendix H (Tables H1 and H6) of final EIS/EIR.

Habitat Quantity/Instream Flow Adaptive Management Model

<u>Factors Affecting Habitat Quantity - Volume</u>
-- **Instream flow releases from diversion dams (controllable)**
-- Unusually high flows (uncontrollable)

<u>Species/Life Stages Affected</u>
-- **All life stages of all species; varies by month and by stream reach**

<u>Key Uncertainties</u>
? IFIM and PHABSIM Model Predictions
? Habitat suitability criteria
? Hydrology Model Predictions
? Climate Change



<u>Monitoring and Data Assessment</u>
– **Monitor anadromous salmonid habitat use**
– **Compare observed and predicted habitat use**
– **Apply significant scientific or model advancements**

<u>Timeline</u>
-- **Apply significant scientific or model advancements as they become available**
-- **Apply habitat use data as accumulated**

<u>Trigger and Response</u>
– **If significant advancements arise then incorporate advancements.**
– **If observed habitat use does not match expectations, then conduct verification study and possibly develop new habitat suitability criteria and recommend changing instream flows.**

Figure 5. Habitat Quantity/Instream Flow Adaptive Management Model.

f. *Water Temperatures*

As water temperature increases toward the extremes of the tolerance range of a fish, biological responses, such as impaired growth and risk of disease and predation, are more likely to occur (Myrick and Cech 2000). Once temperatures exceed the tolerance range for a species at a certain life stage, survival decreases depending on the magnitude and duration of the elevated temperatures. Different life stages and species have different temperature responses, and the tolerance ranges that are identified in available literature are relatively broad (see the discussion under Section 4.1, Fish, in the final EIS/EIR [Jones & Stokes 2005]). Conclusive studies of the thermal requirements completed for Chinook salmon and steelhead in Central Valley streams are limited (Myrick and Cech 2000), but for the purposes of this assessment of effects, survival estimates focused on the most temperature-sensitive life stages at the times of year when these life stages are both present and vulnerable because of climate conditions.

Temperature response survival estimates that were used in this analysis are based on studies reported in the literature and impact analysis techniques used for the same assemblage of fish in the Sacramento River. The presence and absence of temperature-sensitive life stages were based on results of life history studies in the nearby Sacramento River and results of trapping and survey estimates on Battle Creek that have produced juvenile and adult abundance indices (USFWS 2001). Monthly average water temperatures were simulated for the months of June through September under the minimum flow requirements in each reach of Battle Creek for each alternative using SNTEMP (PG&E 2001) (for details, see Appendices K and R of the final EIS/EIR [Jones & Stokes 2005]). It should be noted that the daily temperatures will vary throughout the month, causing the actual mortality relationships to vary throughout the month as well, as fish respond to fluctuations in daily average temperatures; however, the performance of the Restoration Project to baseline conditions on average over a month was used to provide a suitable comparative analysis (PG&E 2008).

Under the Restoration Project, cooler water temperatures will occur in North Fork Battle Creek, after Phase 1A (Figure 6) . These cooler water temperatures will result from the higher minimum instream flow requirements and from the addition of cold water to the North Fork from the Eagle Canyon Spring Complex. The higher instream flow requirements also will extend this cooling into downstream reaches, including mainstem Battle Creek, during the warmer months (Figure 6). The Restoration Project will have minimal effect on water temperatures during October through May, when ambient water temperatures are relatively cool.

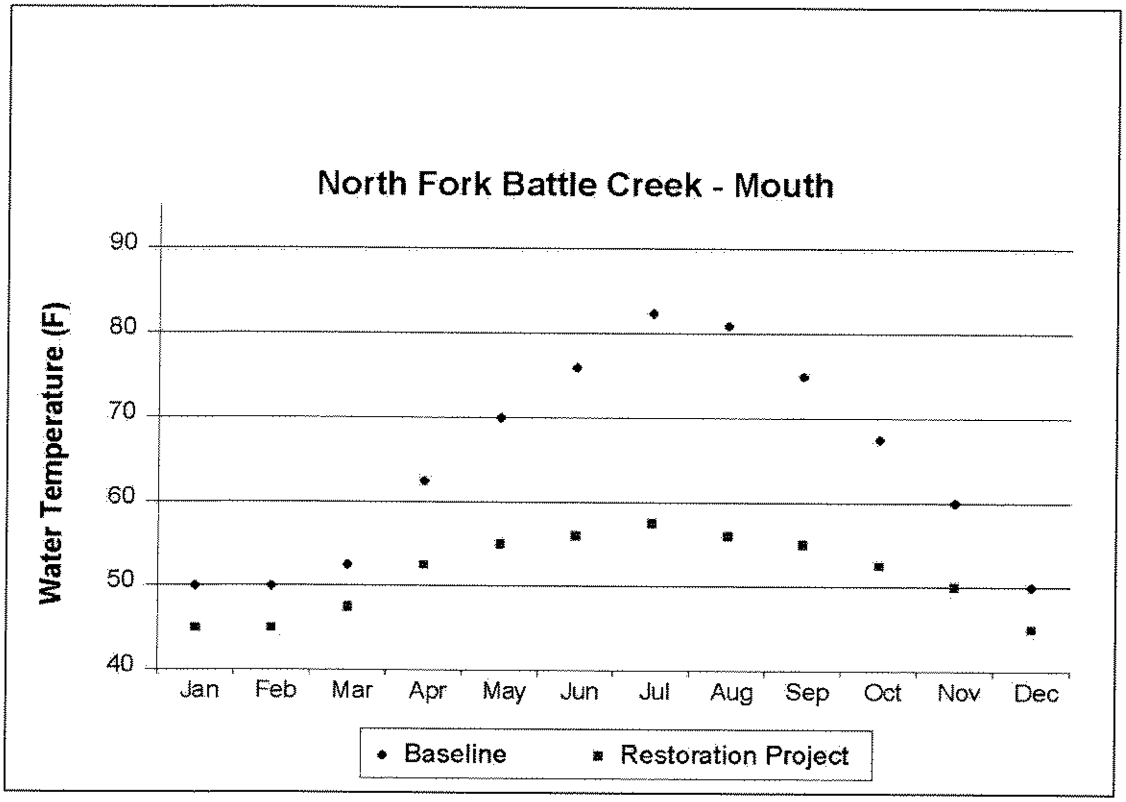


Figure 6. Modeled Water Temperatures in North Fork Battle Creek existing and post-Restoration Project.

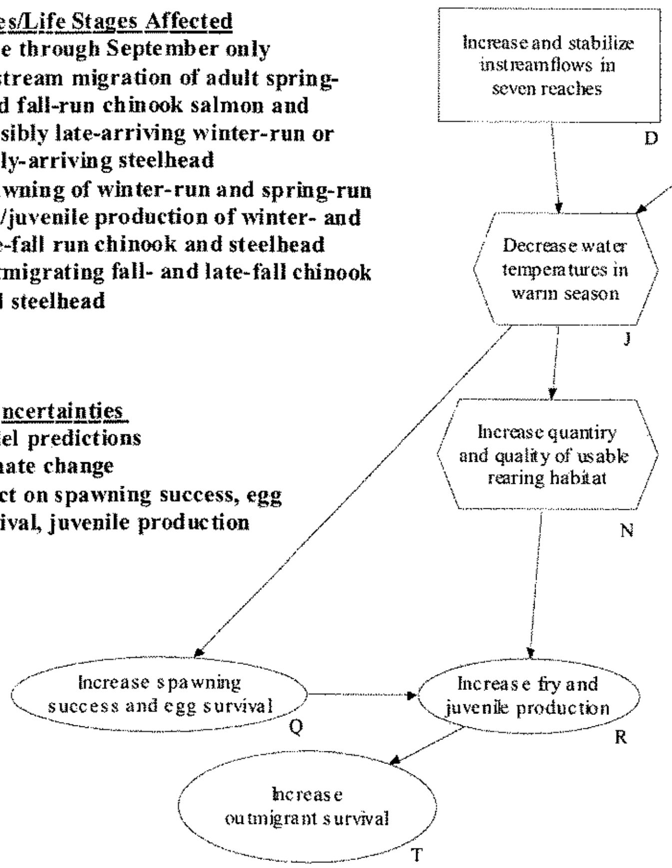
Potential beneficial effects of increased flows on water temperatures in each reach from June through September were estimated using the SNTEMP model described in the EIS/EIR and used by the BCWG Biological Team. A general indication of the magnitude of beneficial water temperature effects over all months of the year is presented using the Warming Model for unspecified runoff and climate conditions described in the EIS/EIR. Both approaches illustrate that during summer months higher flows associated with the Restoration Project substantially reduce water temperatures in most of the affected reaches in Battle Creek. The release of cooler North Fork water into the South Fork by the South and Inskip powerhouses will continue to occur following implementation of Phase 1A, but will be largely discontinued when Phases 1B and 2 are complete.

The Adaptive Management Plan for the Restoration Project recognizes the uncertainty associated with prediction of water temperature regimes and survival rates for different life stages under various environmental conditions. The Adaptive Management Plan includes measures to improve modeling efforts during the post-project period, ways to apply those improvements to real time temperature management in the project area, and measures to provide necessary improvements through the Water Acquisition Fund (Figure 7).

Water Temperature Adaptive Management Model

Factors Affecting Water Temperature
-- Streamflow (controllable, node D)
-- Release of coldspring water (node E)
-- Climate (uncontrollable)
-- Solar radiation (uncontrollable)
-- Topographic shading (uncontrollable)

Species/Life Stages Affected
-- June through September only
-- Upstream migration of adult spring- and fall-run chinook salmon and possibly late-arriving winter-run or early-arriving steelhead
-- Spawning of winter-run and spring-run
-- Fry/juvenile production of winter- and late-fall run chinook and steelhead
-- Outmigrating fall- and late-fall chinook and steelhead



Key Uncertainties
? Model predictions
? Climate change
? Affect on spawning success, egg survival, juvenile production

Monitoring and Data Assessment
-- Monitor climate
-- Monitor longitudinal temperature regime
-- Monitor spring releases
-- Compare actual versus predicted longitudinal temperature regimes
-- Monitor spawner timing, redd distribution, juvenile production, outmigrant condition factor per Population Objective 1

Timeline and Trigger
-- Monitor system-wide climate and temperature for 5 years including one dry/hot year
-- Monitor key water temperature stations for term of AMP
-- Monitor spawning and juvenile production per Population Objective 1
-- If site/time specific temperature goals are not met, implement response

Response
1) Re-model water temperature
2) Develop rule-based plan
3) Increase streamflow/spring release as needed

Figure 7. Water Temperature Adaptive Management Model.

g. *Entrainment into Canals and Turbines*

Fish encountering the intake of a diversion may be entrained. As there have been no specific entrainment studies conducted at the Battle Creek diversions, we must assume that the proportion of the population moving past the diversion that is entrained is equal to the proportion of streamflow that is diverted. Fish that are diverted into the hydropower canals are assumed to suffer total mortality and not contribute to annual production for the species population (Jones & Stokes 2004).

Following Phase 1A, all accessible hydro diversions (North Fork diversions) will be screened. The only issue with entrainment or impingement would be due to failure of a screen. Despite the construction of new fish screens at diversions, operation of screened diversions may continue to result in fish entrainment and impingement if screening facilities experience a mechanical failure. However, monitoring of screened diversions by automated equipment will minimize or eliminate post-screening entrainment and impingement by shutting down diversions when a mechanical failure is detected (Jones & Stokes 2004).

Under Phase 1A of the Restoration Project, entrainment losses will be reduced relative to baseline conditions. Reducing entrainment losses will increase the survival rate of juvenile Chinook salmon and steelhead, which could lead to an increase in the abundance of adult steelhead and Chinook salmon returning to Battle Creek. Removal of the Wildcat Diversion will eliminate the potential for entrainment of juvenile fish at this site. The installation of effective fish screens at North Battle Creek Feeder and Eagle Canyon Diversion Dams will minimize or avoid entrainment-related mortality of fish moving downstream past the diversion intakes. Under Phase 1A of the Restoration Project, the fish ladder at Coleman Diversion Dam (on South Fork Battle Creek) will be blocked to prevent the passage of anadromous fish. This will eliminate the risk of entrainment of anadromous juveniles by the Coleman Diversion Dam until Phase 2 actions to remove the dam are implemented (Jones & Stokes 2004).

Diversions will be screened using designs that meet or exceed criteria established by NMFS and CDFG. Proposed fish screens will have sensors that continuously monitor screen performance. If a malfunction is detected, the automated monitoring system will signal an alarm, and the appropriate operating headquarters will close the canal diversions. Key hydraulic parameters will be monitored at each fish screen for the term of the Adaptive Management Plan. Possible fish entrainment into diversion canals will be assessed visually, especially at times when canals are dewatered. Adaptive management responses, including potential modification of fish screens, may be implemented if fish screen criteria change, facilities do not perform as designed, or fish injury or entrainment is evident. Detailed monitoring, operation, and maintenance plans have been developed for the proposed fish screens and bypass facilities and are described in further detail in the Facility Monitoring Plan for the Hydroelectric Project and the Adaptive Management Plan (Figure 2).

h. *Food Availability*

Food availability and type affect fitness and survival of juvenile salmonids. Flow affects stream surface area and wetted perimeter area, which in turn affect production of food. A primary factor affecting food production in Battle Creek is streamflow. Diversion for power generation has substantially reduced streamflow in all the reaches of Battle Creek downstream of Keswick Diversion Dam and South Diversion Dam. In addition, hydropower diversions entrain food organisms, exporting nutrients from segments of Battle Creek.

The density of adult salmon carcasses has also been shown to increase nutrient input to stream systems and contribute to increased growth rates of juvenile salmonids (Wipfli *et al.* 2002). The historical reduction of Chinook salmon populations may have reduced food availability and productivity of Battle Creek.

Increased minimum instream flows could result in substantially increased production of food for fish and are likely to benefit steelhead and winter- and spring-run Chinook salmon. Prey abundance affects growth rate and the survival of individual fish. The quantity of habitat available for the production of periphyton and aquatic macroinvertebrates is a function of stream surface area. Periphyton is a key component of the aquatic food web, and aquatic macroinvertebrates are a primary food item for fish, especially juvenile Chinook salmon and steelhead. Prey abundance may increase in response to increased stream surface area and subsequent increase in primary productivity. Minimum instream flows would increase under the Restoration Project (see Section 4.3, Hydrology, in the final EIS/EIR [Jones & Stokes 2005]), potentially increasing the abundance of food for fish.

Under baseline conditions, the summer stream surface area is approximately 108.9 acres (Table 10). In response to increased minimum instream flow requirements, the summer stream surface area would increase by approximately 40 acres (37%) after Phases 1A and 1B and 66 acres (60%) after Phase 2 of the Restoration Project. The increase in surface area may increase prey abundance and availability for fish species, including juvenile Chinook salmon and steelhead. This benefit is partially captured under Habitat Quantity (described above), reflecting the effects of increased minimum flow requirements on habitat area and potential production of Chinook salmon and steelhead. Increased prey abundance and availability are a likely prerequisite for increasing the abundance of juvenile Chinook salmon and steelhead in Battle Creek (Jones & Stokes 2004).

Although the additional stream surface area provided by increased minimum flows in Baldwin Creek was not simulated, the stream surface area in Baldwin Creek would increase dramatically compared to the minimal existing surface area under baseline conditions. Increases in stream surface area and resultant macroinvertebrate populations in Baldwin Creek are expected to increase the abundance of prey items, thereby benefitting juvenile Chinook salmon and steelhead production in the Battle Creek watershed (Jones & Stokes 2004).

Table 10. Approximate Summer Stream Surface Area (Acres) by Reach for Minimum Required Instream Flows for Baseline Conditions and the Restoration Project.

Reach	Baseline	Restoration Project Phase 1A
Below Keswick	7.7	7.7
Below North Battle Creek Feeder Diversion Dam	9.9	15.1
Below Eagle Diversion Dam	5.8	9.2
Below Wildcat Diversion Dam	5.7	8.0
Above South Diversion Dam	23.2	23.2
Below South Diversion Dam	19.4	19.4
Below Inskip Diversion Dam	16.1	16.1
Below Coleman Diversion Dam	7.4	9.8
Below Confluence of North Fork and South Fork Battle Creek	13.7	48.5
Total	**108.9**	**149.3**

i. *Predation*

Predation by native and nonnative species may cause substantial mortality of salmonids and other species, especially where the stream channel or habitat conditions have been altered from natural conditions (California Department of Water Resources 1995). The existing diversion dams in the action area may create environmental conditions that increase the probability that predator species will capture juvenile Chinook salmon and steelhead during downstream movement. Water turbulence in the vicinity of the dams and other structures may disorient migrating juvenile Chinook salmon and steelhead, increasing their vulnerability to predators. In addition, changes in water temperature, flow velocity and depth affect the quality of habitat and potentially increase vulnerability of fish species to predation by other fish species, birds, and mammals.

Reduction of predation-related mortality could occur as a result of removing dams and improving fish ladders. Reductions in mortality associated with predation are likely to benefit steelhead and winter and spring-run Chinook salmon. The dams and associated fish ladders present under baseline conditions are assumed to maintain predation above levels that would occur in the absence of dams. The existing dams may stop the upstream migration of predatory species such as pikeminnow, and by enhancing the habitat features that favor them. Juvenile salmonids passing over the dams may be vulnerable to predation as a result of being disoriented by turbulent flow conditions below the dams. High pikeminnow concentrations that coincide with the downstream migration of juvenile salmonids are assumed to increase predation losses (Jones & Stokes 2004).

Under Phase 1A of the Restoration Project, removal of Wildcat Diversion Dam would remove any potential effects of the existing dam on predation. The improved fish ladders at North Battle

Creek Feeder and Eagle Canyon also would minimize disorientation of juveniles, which could improve conditions for downstream migrating Chinook salmon and steelhead. Implementation of the Restoration Project is expected to benefit juvenile Chinook salmon and steelhead populations by reducing predation-related mortality at these locations (Jones & Stokes 2004).

Although predation-related mortality may be reduced as a result of removing dams and improving fish ladders, the overall benefit to Chinook salmon and steelhead populations cannot be quantified. A localized reduction of predator-related mortality may have a greater benefit in reaches where predation is likely more prevalent, such as below Wildcat Diversion Dam. Fish species that prey on juvenile Chinook salmon and steelhead will continue to occur throughout Battle Creek, especially in the lower mainstem reaches where warmer water temperatures support known predators, including smallmouth bass, green sunfish, and Sacramento pikeminnow. The predator populations that occur in lower mainstem Battle Creek are unlikely to be affected by the Restoration Project (Jones & Stokes 2004).

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

A. Aquaculture and Fish Hatcheries

Mount Lassen Trout Farms, Inc. consists of nine private trout-rearing facilities located within the Battle Creek Watershed. This operation rears rainbow and brown trout for stocking in private ponds and lakes throughout California. Although the facilities are located above the anadromous habitats of Battle Creek, some facilities are located near the hydroelectric project canals. These facilities have been certified as disease free for many years and the potential for fish or disease to escape from these facilities into Battle Creek is considered very small. No such impacts have ever been documented from these facilities and they are not expected to occur in the future.

Darrah Springs Fish Hatchery is located on Baldwin Creek, a tributary to mainstem Battle Creek. It is a key hatchery of CDFG's inland fisheries program and raises catchable trout for recreational fisheries. It is possible that fish or disease could escape the hatchery into Battle Creek, but again, no such impacts have ever been documented and are not expected to occur in the future.

B. Agricultural Practices

The primary agricultural practices in the Battle Creek Watershed consist of low density livestock grazing and small timber harvests. These practices have not produced measurable adverse impacts to salmonids or salmonid habitat in Battle Creek (Reclamation 2003). There are no current plans to modify the type or intensity of agricultural practices in the watershed and therefore any such changes could not be considered reasonably certain to occur. As discussed in the next section, conservation easements and agreements are being pursued along the riparian corridors of the Battle

Creek Watershed, providing further assurance that future agricultural and other human practices will not be likely to adversely affect salmonids or salmonid habitat.

C. Conservation Agreements and Easements

The Battle Creek Watershed Conservancy and The Nature Conservancy have been working together in developing conservation agreements and easements throughout the riparian corridors and uplands of the Battle Creek Watershed. Several agreements and easements have already been established and several more are being pursued. More specifically, TNC has purchased approximately 7,000 acre's of conservation easements on ranches within Battle Creek's watershed. They have also purchased in fee the 1,844 acre Wildcat Ranch on North Fork Battle Creek. This ranch provides access for the Restoration Project's removal of Wildcat Dam. TNC continues to negotiate for the purchase of new easements along both forks of Battle Creek. All TNC easements on Battle Creek prohibit development and other land uses that threaten salmonids. Implementation of these agreements and easements is expected to, at a minimum, maintain the current high quality of riparian and aquatic habitat in Battle Creek, and could potentially improve the condition of these habitats for salmonids.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

The purpose of this section is to summarize the effects of the action and add those effects to the impacts described in the "Environmental Baseline" and "Cumulative Effects" sections of this biological opinion in order to inform the conclusion of whether or not the proposed action is likely to jeopardize the continued existence of the listed salmonids, or destroy or adversely modify designated critical habitat.

Populations of Chinook salmon and steelhead in California have declined drastically over the last century, and some subpopulations have been extirpated. The current status of listed salmonids within the action area, based upon their risk of extinction, has not significantly improved since the species were listed (Good *et al.* 2005). For example, although the number of Sacramento River winter-run Chinook salmon had increased from 2000 to 2006, the ESU remains at risk of extinction (Good *et al.* 2005). This severe decline in population over many years, and in consideration of the degraded environmental baseline, demonstrates the need for actions which will assist in the recovery of all of the ESA-listed species in the action area, and that if measures are not taken to reverse these trends, the continued existence of salmonids could be at risk.

A. Impacts of the Proposed Action on ESU/DPS Survival and Potential for Recovery

The Effects of the Action section acknowledges and analyzes the continued effect of operating the Project based on the proposed action. Certain effects of the Hydroelectric Project, such as blockage of access to South Fork Battle Creek, continuation of some mixing of North Fork Battle Creek into South Fork Battle Creek (affecting homing success), and false attraction during power house outages (planned and unplanned) are expected to continue into the future.

However, the most significant long-term effect of implementing Phase 1 A of the Restoration Project will be to improve overall conditions for listed salmonids by increasing the amount of high quality habitat available. This increase in high quality habitat will be achieved through removing passage barriers, increasing minimum instream flows, and thereby reducing temperatures during critical periods, reducing juvenile entrainment into hydropower diversions, increasing food availability (through increase in surface area) and eliminating some mixing of North Fork waters into South Fork Battle Creek. Furthermore, the Interim Flow Agreement will provide increased flow and decreased temperature benefits to South Fork Battle Creek below Coleman Dam until Phase 2 of the Restoration Project is complete.

The adverse effects that are anticipated to result from the continued operation of the Hydroelectric Project following implementation of Phase 1A of the Restoration Project are not of the type or magnitude that would be expected to appreciably reduce the likelihood of survival and recovery of the affected species within the action area. NMFS expects that any adverse effects of this project will be greatly outweighed by the long-term benefits to species survival produced by the improvement in spawning, rearing and holding habitat for all three listed salmonids in Battle Creek.

Overall, the implementation of Phase 1A of the Restoration Project is expected to contribute to the recovery of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead by expanding and enhancing available spawning and rearing habitat in North Fork Battle Creek. The proposed action will contribute to the long-term viability of the listed salmonids in Battle Creek by enhancing population abundance, growth rate, and spatial structure (McElhany et al. 2000). Strengthening the Battle Creek populations should contribute to the survival and recovery of the overall Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon ESUs and the Central Valley steelhead DPS (NMFS 2006).

B. Impacts of the Proposed Action on Critical Habitat

The long-term effects of the Restoration Project are anticipated to be highly beneficial to these species and are expected to greatly enhance the conservation value of designated critical habitat in Battle Creek.

VIII. CONCLUSION

After reviewing the best scientific and commercial data available, including the current status of the listed salmonid species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the continued FERC operations outlined in the FERC amendment application for implementation of Phase 1A of the Restoration Project is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead.

In addition, NMFS has determined that the FERC action, as proposed, is not likely to destroy or adversely modify critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by FERC so that they become binding conditions of any licenses issued, as appropriate, for the exemption in section 7(o)(2) to apply. FERC has a continuing duty to regulate the activities covered by this Incidental Take Statement. If FERC: (1) fails to assume and implement the terms and conditions; or (2) fails to require the licensees to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the license, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, FERC must report the progress of the action and its impact on the species to NMFS as specified in this Incidental Take Statement (50 CFR §402.14(I)(3)).

A. Amount or Extent of Take

NMFS anticipates incidental take of Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, and Central Valley steelhead through continued operations of the Battle Creek Hydroelectric project. Specifically, NMFS anticipates that incubating eggs, fry, juvenile, and adult spring- and winter-run Chinook and steelhead may be killed, injured, or harassed during continued operations of the Battle Creek Hydroelectric Project.

NMFS cannot, using the best available information, specifically quantify the anticipated amount of incidental take of individual listed fish because of the variability and uncertainty associated with the response of listed species to the effects of the project, the varying population size of each species, annual variations in the timing of spawning and migration, and individual habitat use within the project area. In addition, detection of killed or injured individuals is unlikely to occur without extensive in-river monitoring efforts.

However, it is possible to designate as *ecological surrogates*, those elements of the project that are expected to result in take, and that are also somewhat predictable and/or measurable, and to monitor those surrogates to determine the level of take that is occurring. The most appropriate ecological surrogates for the extent of take to be caused by the project are the frequency and duration of planned and unplanned canal and powerhouse outages resulting in flow fluctuations in areas accessible to anadromous fish, and the performance and effectiveness of the new fish screens and ladders in providing safe passage conditions for fish.

The period of time that fish will continue to be blocked at Coleman Diversion Dam, and that North Fork water will be mixed into the South Fork (time before implementation of all phases of the Restoration Project) would also be a good ecological surrogate for the extent of take to be caused by these elements of the project. But because there are no estimates of the length of this period given, it would be impossible to measure the success or failure of such a surrogate against any predicted outcome. Therefore, the analysis of the proposed project must assume that the take resulting from these elements of the Hydroelectric Project will continue throughout the life of the license.

1. <u>Ecological Surrogates</u>

a. *Flow Fluctuations Due to Outages*

The analysis of the effects of the proposed project anticipates that there will be approximately 10 planned or unplanned outages a year resulting in a range of flow increase from 55 cfs to 340 cfs lasting for 3 to 4 days each, also, less than 5 of these outages every 5 years lasting for approximately 10 days each. In addition, some short duration increases in flow resulting from abnormal or unplanned project operations are expected to occur less than 10 times per year resulting in flow increases ranging from 75 cfs to 340 cfs expected to last from a few minutes to 12 hrs. As a result of these outages/increased flows, take in the form of reduced spawning success and/or death may occur in the following incidences:

(1) Adult winter- and spring-run Chinook salmon may become falsely attracted into South Fork Battle Creek during temporarily increased flows occurring during their migration. Once the hydro-system is returned to normal operations, lower flows and warmer water temperatures during the summer months in South Fork Battle Creek may lead to reduced spawning success and/or pre-spawn mortality in these adults.
(2) Juvenile winter- and spring-run Chinook salmon and steelhead may become stranded and die as these increased flows recede.
(3) Sudden increases in flows could result in heavy silt and debris covering and smothering eggs.

b. *Effectiveness of Fish Screens and Ladders*

The analysis of the effects of the proposed project anticipates that the new fish screens and ladders will be constructed and maintained in a manner that insures their continued compliance with all NMFS fish screen and ladder criteria, and that these facilities will be monitored and adaptively managed to insure their continued efficacy throughout the life of the project

If the specific parameters of these ecological surrogates are exceeded, the proposed project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the project.

B. Effect of the Take

In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead. In addition, NMFS determined that this level of anticipated take is not likely to result in the destruction or adverse modification of designated critical habitat for Central Valley spring-run Chinook salmon or Central Valley steelhead.

C. Reasonable and Prudent Measures

Pursuant to section 7(b)(4) of the ESA, the following reasonable and prudent measures are necessary and appropriate to minimize take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead:

1. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, FERC must require that PG&E comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

The Restoration Project was originally planned and designed for implementation to occur within one single phase, with the AMP and FMP to commence implementation once restoration construction activities were completed. However, since the Restoration Project has now been split into several phases, it is unclear within the project documents whether or not the AMP and FMP would begin immediately following implementation of Phase 1A. Therefore, the requirements listed below (a, b, c) ensure the AMP and FMP begin as soon as Phase 1A is complete. In addition, the Interim Flow Agreement was intended to be in place until the Restoration Project was completed. Therefore, the requirement listed below (e) is to ensure the Interim Flow Agreement continues until Phase 2 has been completed.

a. FERC shall require PG&E to form the Adaptive Management Policy Team and the Adaptive Management Technical Team upon issuance of the amended license.

b. FERC shall require PG&E to implement all Adaptive Management Plan components applicable to Phase 1A of the Restoration Project.

c. FERC shall require PG&E to implement all Facilities Monitoring Plan components applicable to Phase 1A of the Restoration Project.

d. FERC shall require PG&E to coordinate with NMFS, USFWS and DFG to determine the best timing for planned outages, inform the agencies of upcoming planned outages, and alert the agencies of any emergency (unplanned) outages.

e. FERC shall require PG&E to consult with the representatives of the Interim Flow Science Team and insure that appropriate interim flows (as established in the Interim Flow Agreement) will continue until completion of Phase 2 of the Restoration Project.

f. FERC shall require PG&E, in consultation with NMFS, to develop and implement a plan to provide appropriate flows (up to 60 cfs) below Coleman Dam, to minimize adverse affects on holding spring-run Chinook salmon that are falsely attracted into South Fork Battle Creek as a direct result of a PG&E operations outage/mixing. The plan should cover the interim period between the issuance of the amended license and the completion of all elements of Phase 2 of the Restoration Project.

g. FERC shall require PG&E to report any detected incidences of take of listed salmonids within 48 hours to NMFS at the contact information below.

Updates and reports required by these terms and conditions shall be submitted to:

Supervisor
Sacramento Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento CA 95814
FAX: (916) 930-3629
Phone: (916) 930-3600

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. These conservation recommendations include discretionary measures that FERC can take to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat or regarding the development of information. In addition to the terms and conditions of the Incidental Take Statement, NMFS provides the following conservation recommendation that will reduce or avoid adverse impacts on the listed species:

1. FERC should encourage PG&E to work with Reclamation to complete Phases 1B and 2 as quickly as possible to open up habitat on the South Fork that is currently blocked by the Hydropower Project; and to minimize North Fork water mixing with South Fork water.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed Battle Creek Hydroelectric project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Enclosure 2

Magnuson-Stevens Fishery Conservation and Management Act

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS[1]
FERC Battle Creek Hydroelectric Project (Hydroelectric Project)

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NOAA's National Marine Fisheries Service (NMFS) on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and, "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. The proposed project site is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon FMPs.

The Pacific Fishery Management Council (PFMC) has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon FMP (PFMC 1999). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific Coast Salmon FMP that occur in the Central Valley. The enclosed biological opinion (Enclosure 1) thoroughly addresses the species of Chinook salmon listed both under the Endangered Species Act (ESA) and the MSA which potentially will be affected by the proposed action. These include the Sacramento River winter-run Chinook salmon and the CV spring-run Chinook salmon. Therefore, this EFH consultation will concentrate primarily on the CV fall/late fall-run Chinook salmon which is covered under the MSA, although not listed under the ESA.

[1] The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) set forth new mandates for NOAA's National Marine Fisheries Service (NMFS) and Federal action agencies to protect important marine and anadromous fish habitat. Federal action agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential adverse effects of their actions on EFH, and respond in writing to NMFS "EFH Conservation Recommendations." The Pacific Fisheries Management Council has identified essential fish habitat (EFH) for the Pacific salmon fishery in Amendment 14 to the Pacific Coast Salmon Fishery Management Plan.

Fall-run Chinook salmon comprise the largest population of Chinook salmon in Battle Creek. Fall-run Chinook salmon are intentionally restricted from migrating upstream of CNFH barrier weir because of concern about transmitting infectious hematopoietic necrosis (IHN) into the water supply for the Coleman National Fish Hatchery (FWS 1997) and potential problems that excessive numbers of fall-run fish pose to the small numbers of spring- and winter-run Chinook salmon. The abundance of fall-run Chinook salmon in the Battle Creek watershed has increased substantially since about 1980. Recent years prior to 2006, an average of about 95,000 adult fall-run Chinook salmon returned to Battle Creek, of which an average of nearly 34,000 were allowed to enter the Coleman National Fish Hatchery. However, the last three years have each declined with a low of 14,925. The remaining fall-run Chinook salmon are mostly confined downstream of the Coleman National Fish Hatchery barrier weir, outside the project area (FWS 2001). Fishery managers have conventionally believed that most of these fall-run Chinook salmon are directly of Coleman National Fish Hatchery origin (Kier Associates 1999). However, recent research suggests that as many as one-third of the fall-run Chinook salmon returning to the creek were the product of fish that spawned naturally in lower Battle Creek (FWS 2001).

A. Life History and Habitat Requirements

1. Pacific Salmon

General life history information for Central Valley fall-run Chinook salmon is summarized below. Further detailed information on the other Central Valley Chinook salmon Evolutionarily Significant Units (ESUs) are available in the enclosed biological opinion, the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (63 FR 11482).

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through December and spawn from October through December while adult Central Valley late fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from October to April and spawn from January to April (U.S. Fish and Wildlife Service [FWS] 1998). Chinook salmon spawning generally occurs in clean loose gravel in swift, relatively shallow riffles or along the edges of fast runs (NMFS 1997).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean. Whether entering the Delta or estuary as fry or larger juveniles, Central Valley Chinook salmon depend on passage through the Delta for access to the ocean.

II. PROPOSED ACTION

The proposed action is described in detail in section II (*Description of the Proposed Action*) of the enclosed biological opinion (Enclosure 1).

III. EFFECTS OF THE PROPOSED ACTION

The Hydroelectric Project is expected to have a relatively neutral effect on fall-run Chinook salmon EFH as fall-run fish currently are excluded from the area where the primary effects will occur (above the CNFH barrier weir) for management purposes discussed above. The adaptive management plan for the Restoration project allows for the potential re-establishment of a natural fall-run of Chinook salmon population in the Restoration project area, but only after healthy, viable populations of the listed Chinook salmon become established, and it is determined that a managed population of natural fall-run can be allowed to develop in the area without adversely affecting the other listed populations of Chinook salmon (Terraqua 2004). Additionally, all flows diverted for hydropower under PG&E's operations are returned to Battle Creek above the CNFH barrier weir, and thus have negligible effects on flows and temperatures in the area accessible to CV fall-run Chinook salmon.

In this manner, the Hydroelectric Project is not expected to adversely affect fall-run Chinook salmon EFH during the amended FERC license after Phase 1A of the Restoration project (because fall-run fish are excluded from the area above CNFH barrier weir), but there is a potential for the full reconstruction/restoration of the Hydroelectric Project to have a positive effect on fall-run Chinook salmon over time, due to the potential for opening up new habitat for them in the future.

As discussed above, EFH protections apply to all ESUs of Pacific Chinook salmon, so the adverse operation effects that will impact the habitat occupied by spring-run Chinook salmon are also considered adverse effects on EFH. Those effects are thoroughly detailed in the biological opinion for the Battle Creek Hydroelectric Project (Enclosure 1).

IV. CONCLUSION

Based on the best available information, and upon review of the effects of the proposed FERC Battle Creek Hydroelectric Project, NMFS believes that the proposed actions will have negligible effects on EFH occupied by CV fall-run Chinook salmon and adverse effects on EFH occupied by CV spring-run Chinook salmon and Sacramento River winter-run Chinook salmon protected under MSA.

V. EFH CONSERVATION RECOMMENDATIONS

As the adverse effects to EFH associated with the proposed project will generally occur in the critical habitat utilized by the federally listed species addressed in the enclosed biological opinion, NMFS recommends that reasonable and prudent measure number 1 and the respective implementing terms and conditions as well as conservation recommendation number 1 described in the enclosed biological opinion, be adopted as EFH conservation recommendations. Those terms and conditions which require the submittal of reports and status updates can be disregarded for the purposes of this EFH consultation as there is no need to duplicate those submittals.

VI. STATUTORY REQUIREMENTS

Section 305 (b) 4(B) of the MSA requires that the Federal lead agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the lead agency for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR '600.920[j]). In the case of a response that is inconsistent with our recommendations, the lead agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

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